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The
Nineteenth
Annual Report.

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VOLUME NO. 19
OF THE
Maryland Agricultural Experiment Station,
COLLEGE PARK, MD.
1905-1906.

THE

Maryland Agricultural Experiment Station.

CORPORATION.

The Board of Trustees of the Maryland Agricultural College.

Agricultural (Station) Committee of the Board of Trustees.

Governor Edwin Warfield (Ex-Officio)	Annapolis.
Charles H. Stanley (Chairman)	Laurel.
David Seibert	Clear Spring.
Murray Vandiver	Havre de Grace.
Chas. A. Councilman	Glyndon.
F. Carroll Goldsboro	Easton, Md.

Station Officers and Staff.

Harry J. Patterson, B. S.	*Director and Chemist.*
Joseph R. Owens, M. D.	*Treasurer.*
Samuel S. Buckley, D. V. S.	*Veterinarian.*
W. T. L. Taliaferro, B. A.	*Agronomist.*
J. B. S. Norton, M. S.	*Botanist and Pathologist.*
E. O. Garner	*Farm Superintendent and Recorder of Experiments.*
Thos. B. Symons, M. S.	*Entomologist.*
Wm. N. Hutt, B. S.	*Horticulturist.*
F. H. Blodgett, M. S.	*Assistant Botanist.*
M. N. Straughn, M. S.	*Assistant Chemist.*
A. B. Gahan, B. S.	*Assistant Entomologist.*
C. W. Nash, B. S.	*Assistant Agronomist.*
W. R. Ballard, B. S.	*Assistant Horticulturist.*
Raymond Outwater, M. S.	*Assistant Chemist.*
O. C. Gibbs	*Clerk.*
Thos. H. White	*Gardener.*

The Station is located on the B. & O. R. R. and City & Suburban Electric Car Line, eight miles north of Washington, D. C.
Bell Telephone—Hyattsville 4 R.

Visitors will be welcomed at all times, and will be given every opportunity to inspect the work of the Station in all of its departments.

The Bulletins and Reports of the Station will be mailed regularly, free of charge, to all residents of the State who request it.

ADDRESS:
AGRICULTURAL EXPERIMENT STATION,
College Park, Maryland.

THE

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ANNUAL REPORT

OF THE

MARYLAND

Agricultural Experiment Station,

COLLEGE PARK

PRINCE GEORGE'S CO., MARYLAND.

1905–1906.

PUBLISHED BY THE STATION.

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College Park, Maryland.

LETTER OF TRANSMITTAL.

To His Excellency, Edwin Warfield,

Governor, and President of the Board of Trustees,

Annapolis, Md.

Sir:—In accordance with the provisions of Section No. 3, of the Act of Congress, approved March 2, 1887, "To Establish Agricultural Experiment Stations, etc.," I have the honor to transmit the Nineteenth Annual Report of the Maryland Experiment Station for the fiscal year ending June 30, 1906.

Very respectfully yours,

H. J. PATTERSON,

July, 1906. Director of the Experiment Station.

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THE MARYLAND
AGRICULTURAL EXPERIMENT STATION.

Volume 19. 1905-1906.

Report on the Work and Expenditures of The Maryland Agricultural Experiment Station.

FOR THE YEAR ENDING JUNE 30, 1906.

By H. J. PATTERSON, Director.

In general the Experiment Station of this State may be said to be in a satisfactory and healthy condition, as is evidenced by the constantly increasing number of farmers who are taking an interest in the investigations in progress, and asking for publications, and, also, looking to this place, by correspondence and visits, for help on every conceivable question with which farmers may come in contact.

EXPERIMENTS IN PROGRESS.

The experiments in progress at the present time are in the main a continuation of those outlined in the Eighteenth Annual Report. All of the departments are now undergoing some expansion and planning for new lines of work, owing to the increased income of the Station.

MAILING LIST.

In accordance with the plan suggested some time ago, and which was approved by the Board, the mailing lists of the Experiment Station, The Fertilizer and Food Stuff Control, and The State Horticultural Department have all been consolidated. This plan, so far, is working satisfactorily and proving more economical for the other departments and enabling the farmers to get all our publications without confusion. The mailing lists are sub-divided and classified as follows:

1. Newspapers in Maryland.
2. Agricultural Papers.
3. Libraries.
4. Farmers' Clubs in Maryland.
5. Maryland Granges.
6. General Mailing List of Farmers in Maryland.

7. Fertilizer Manufacturers.
8. Horticultural List.
9. Tobacco Growers List.
10. Creamery Patrons List.
11. Milk Shippers List.
12. Farmers outside of Maryland.
13. Experiment Station Officers and Workers.
14. Foreign List.

By having the list sub-divided in this manner we are enabled to reach any particular interest desired.

The general mailing list now contains about 20,000 names. This is four times the number that was on the list when it was revised in 1899.

PUBLICATIONS.

Through the pressure of other duties some of our officers have not been able to put into shape, as was expected, some matter which should have been issued in bulletin form the past year. The following is a list of those which have been sent out:

No. 104 Tests of Materials for Bedding Cows, Chas. F. Doane

No. 105 Fumigating Nursery Stock, T. B. Symons and A. B. Gahan.

No. 106 The Influence of the Size of the Grain and the Germ of the Corn upon the Plant, E. P. Walls.

No. 107 1905—Spraying Experiments for San Jose Scale, T. B. Symons and A. B. Gahan.

No. 108 Irish Potato Diseases, J. B. S. Norton.

No. 109 Mosquitoes, T. B. Symons, A. B. Gahan, and T. H. Coffin.

SALARIES OF STATION OFFICERS.

The question of the salaries of Station workers is ever coming up for more or less consideration and is always to some extent perplexing. With the past condition of the Station finances there was little left but to accept the inevitable and pay only as much as the funds would allow. With the increased income I believe that the importance of the work in hand demands a re-adjustment of salaries and a full recognition of the conditions as they exist, so as to place our work on a substantial and more permanent basis and not submit to the frequent interruptions and changes to which we have been subjected in the past.

In the first place, in looking for and holding men we must recognize the principle that exists in and dominates all other marketable commodities; that is, the supply and demand, and the quality.

In men for different classes of work these facts effect the salaries which they command just as much as they do horses or dry goods.

In Station work we want men who will not only occupy but fill the position.

The schedule of salaries in force at the present time has made it difficult to hold good men when we have had them and it makes it exceedingly difficult to procure the kind of men we actually need for much of our work; and I would therefore suggest the desirability of a re-adjustment of the salaries of Station investigators and that they be paid commensurate with the work required. At the present time the salaries of Station men is regulated by those in force for the College professorships and to some extent this forms a false basis for calculation.

The qualities which make up a good investigator is much more rare than that of the teacher and consequently makes them harder to get. Again, the college professor is actually employed between three and four months less time during the year than the Station worker, and then, too, the College professor has shorter hours per day and all of Saturdays to himself. Taking all of these facts into consideration it would seem but reasonable that the pay should be at least in proportion to the amount of time required on duty. Then again, we must recognize the great demand for investigators all over the United States and Canada and be prepared to pay what other institutions are offering or content ourselves with a lower grade of help.

I trust that these suggestions will be given careful consideration, and steps be taken to correct the difficulties which have been confronting us in the past.

With the present demand for scientific men the interest of our Station makes it doubly important that a more liberal policy be fixed with reference to the salaries of those occupying assistants positions. With the present arrangement we are little more than a training ground, and about the time a man becomes valuable he is taken by some other place and we must look for and train a new man.

CLERK AND STENOGRAPHER.

The keeping of many of our records, as well as much important work of a miscellaneous character, devolves on the clerk of the Station, and consequently this position should be made more staple in character than it has been up to this time. Our work is not ordinary correspondence and demands more ability than is found in ordinary stenographers and typewriters. During the eighteen years of the Station's existence we have had fourteen different people in this capacity; all of them leaving us for better paying positions. The greatest length of service has been two years. I would recommend that a higher allowance be made for this position and the pay made commensurate with the services rendered.

In the early days of the Station the clerk in addition to acting as stenographer and typewriter also had considerable time to look after the library, mailing list, and many other matters. Now that the correspondence and other classes of typewriting has grown to such proportions as to occupy practically all the time of the clerks, the library in a large measure takes care of itself, and some extra labor has to be employed for the mailing department. Our library is now in a bad shape, as it has never been catalogued and systematically arranged. The lack of this is of daily annoyance to our workers, and is badly needed so as to make the books accessible to the College students and others. Again, for lack of some one to look after the library our files of many reports, bulletins, etc., are not kept up; books are taken out of the library and not put back in their proper places; and, indeed many are removed and never returned and are consequently lost to our library. I therefore recommend that some one be employed temporarily to at once catalog and classify our library under the system adopted in the library of the United States Department of Agriculture, and that as soon as funds are available that some one be employed permanently to act as librarian, mailing clerk, and secretary, and who will be skilled in all of these classes of work and who will also be able to assist in proof reading and other systematic work in connection with Station records.

STATION STAFF.

Mr. E. P. Walls resigned the position of Assistant Agronomist on October 1st, 1905, to take up the study of medicine at Johns Hopkins University. The vacancy caused by this resignation was filled by the appointment of C. W. Nash, B. S., of Iowa State College who entered upon his duties November 1st, 1905.

S. B. Shaw, B. S., Assistant Horticulturist, resigned October 1st, to accept the position of agricultural agent in the Industrial Division of the B. & O. R. R. This vacancy was filled by the appointment of W. R. Ballard, B. S., of Kansas State College, who entered upon his duties February 15th, 1906.

Mr. H. H. Howell resigned as clerk to the Station and the vacancy has been filled by the appointment of Mr. O. C. Gibbs, of Tuxedo, Md. Mr. Gibbs is a brother of Mr. B. H. Gibbs who served us faithfully as clerk for the two years previous to Mr. Howell's appointment.

The work on breeding sweet corn was enlarged and a plan for cooperation with the United States Department of Agriculture was entered upon, which necessitated Mr. M. N. Straughn devoting all of his time to this one subject, consequently more help was required for the general chemical work. This was provided for by the appointment of Mr. Raymond Outwater, M. S., of George Washington University, to the position of Assistant Chemist, who commenced work on March 15th, 1906.

BUILDINGS.

In accordance with the authorization of the Board and of the Agricultural Committee we now have under construction one house for a laboring man. On getting bids for this house it was found that lumber had advanced considerably and at the same time seemed to be of poorer quality, consequently after considerable investigation it was thought best to try the construction of a hollow cement block house instead of frame and to keep accurate account of everything so as to have this information for the public.

There is much interest in cement structures and farmers in many parts of the State are looking for a substitute for lumber and brick. The cement block house will be little, if any, more expensive than the frame and will require no painting, so that the expense of repairs and insurance will be reduced to a minimum.

Through the resolution of the Board there will be $5000 of the appropriation of 1904 available to the Station for building purposes. The use of this money has been considered by the Agricultural Station Committee and by the Board of Trustees, and they have decided that this money be appropriated, or so much as may be necessary, for the construction of dairy and feeding barns which would be adapted to investigation work.

The present barn has proved poorly adapted to Station work and it has not proved practical or even to substantiate the claims of its architect. An experiment station barn should meet the following requirements:

1st. It should be so planned as to be easily adapted to a great variety of investigations.

2nd. It should meet the requirements of modern ideas of sanitation, ventilation, light, etc.

3rd. It should be planned so as to facilitate work and reduce labor as far as possible to a minimum.

4th. Dairy and horse barns should be separate.

5th. Barns for feeding and dairy investigations should be planned so as to make possible the exclusion of persons not connected with the work unless accompanied by an attendant. (In this connection I would say that every experiment attempted with the dairy herd the past year has been seriously interfered with by students gaining access to the barn and milking the cows.)

6th. So far as possible the barns should serve as models and be suggestive of ideas to farmers who are looking into the question of plans for dairy buildings and in order to produce sanitary milk inexpensively.

In making this decision the present barn will not become useless and discarded, but it will continue to be of use for the following purposes:

1st. As at present for stabling the College and President's horses.

2nd. A portion of the first floor can be fitted up for a live stock judging pavilion.

3rd. A portion of the first floor will be used for veterinary work.

4th. A portion of the second floor will be needed for a laboratory for cereal investigations.

5th. The balance of the second floor can be profitably used for farm machinery investigations and tests, which will probably be taken up at some future time, and for use as an agricultural museum.

COOPERATIVE WORK.

The cooperative work outlined in previous reports is all being continued with the exception of that with the United States Department Maltese milch goats, which has been suspended owing to the presence of the Malta fever germ in the blood of some of the animals. This work may be taken up later with other goats.

RELATION OF COMBINED COLLEGE AND STATION WORKERS.

Owing to the unsatisfactory results attending many of the investigations conducted by combined College and Station men it seems necessary that some different plan from that in vogue at present be adopted. A careful consideration of this matter by all parties interested has led to the conclusion, and adoption of the plan, that as far as practicable the work of combined men should be grouped, so as to give continuous service to one or the other of the institutions for a given period and at which time the respective officer would have no duties with the other division of his work. This plan will cause as little interruption to the investigations in charge as possible. In this connection it is arranged that the new specialists to be employed at the Station be available for College work, provided their services are desired, upon the basis that the work desired shall be concentrated into one period and that the services shall be paid for by the College in proportion to the time consumed.

FINANCIAL REPORT.

The income of the Experiment Station for the next fiscal year will be increased by the funds made available by the appropriation made by the United States Congress, known as the "Adams' Act." This act gives to each State an appropriation of $5000 the first year, to be increased annually $2000, until the total amount reaches $15,000. The State Legislature has appropriated $5000 additional for the next year and also provided for $4000 for horticultural investigations in the State Horticultural Department bill.

The following is a statement of the receipts and expenditures of the Station during the past year as submitted by the Station Treasurer:

MARYLAND AGRICULTURAL EXPERIMENT STATION IN ACCOUNT WITH THE UNITED STATES APPROPRIATION.

Dr.

1906.		
June 30,	To receipts from the Treasurer of the United States, as per appropriations for the fiscal year ended June 30, 1906, as per act of Congress March 2, 1887	$ 15,000.00

Cr.

1906.		
June 30,	By Salaries	$ 7,757 36
"	Labor	3,010 37
"	Publications	452 01
"	Postage and Stationery	329 30
"	Freight and Express	260 01
"	Heat, Light and Water	380 22
"	Chemical Supplies	261 69
"	Seeds, Plants, and Sundry Supplies	115 27
"	Fertilizers	213 60
"	Library	280 98
"	Feeding Stuffs	371 30
"	Tools, Implements and Machinery	225 55
"	Furniture and Fixtures	48 55
"	Scientific Apparatus	9 45
"	Live Stock	247 00
"	Traveling Expenses	735 64
"	Contingent Expenses	15 00
"	Buildings and Repairs	286 70
	Total	15,000 00

The above is a true copy from the books of this office.

(Signed.) JOSEPH R. OWENS,

Treasurer Maryland Agricultural Experiment Station.

MARYLAND AGRICULTURAL EXPERIMENT STATION IN ACCOUNT WITH THE STATE OF MARYLAND APPROPRIATION.

Dr.

1905.		
July 1,	To Cash Balance	$ 1,208 21
1906.		
June 30,	Receipts from the State of Maryland for the fiscal calendar year ending September 30, 1906	10,000 00
		$11,208 21

Cr.

June 20,	By Repairs	$ 1,646 86
"	Publications	982 23
"	Exhibits	1,601 12
"	Feeding Experiments	1,881 65
"	Tobacco Experiments	615 93
"	Insurance	177 25
"	Balance	4,303 17
		$11,208 21

MARYLAND AGRICULTURAL EXPERIMENT STATION IN ACCOUNT WITH THE STATION FARM.

Dr.

1906.		
June 30,	To Sales of Stock and Produce since July 1, 1905	$5,182 63

Cr.

1906.		
June 30,	By Labor	$ 3,400 00
"	Seeds, Plants, and Sundry Supplies	1,033 87
"	Fertilizers	400 00
"	Contingent Expenses	187 25
"	Tools, Implements, and Machinery	140 10
"	Cash Balance	21 41
		$5,182 63

The above is a true copy from the books of this office.

(Signed.) JOSEPH R. OWENS,

Treasurer Maryland Agricutural Experiment Station.

THE MARYLAND
AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 104. JULY, 1905.

Tests of Materials for Bedding Cows.

By Chas. F. Doane.

The supplying of sufficient good bedding for the herd will always be an interesting and, sometimes, a serious problem where the farm is devoted exclusively or largely to dairying. Farmers depend, as a rule, on the wheat straw for bedding, and, where only a comparatively few cows are kept, and the usual system of rotation in crops is practiced with wheat, followed by grass and this by corn, there will be, except in years of a very short wheat crop, plenty of bedding for all purposes.

But where dairying is the principal industry of the farm, and everything else tributary to it, the bedding material is likely to be very short for two different reasons. One is, that more of the land is required to produce feed for the herd, and as wheat is not a dairy food, the area devoted to this crop is cut down. Moreover with the extra manure supplied by the comparatively large number of cows kept, it is not necessary to practice so closely a system of rotation to maintain the fertility of the land. The extra manure will insure not only that the fertility will be maintained, but actually increased without adhering to a rotation. Still this fact furnishes, in part, its own remedy, for well manured land tends to grow abnormal amounts of forage or of straw, and, under these conditions, land will produce almost twice as much straw as under ordinary conditions.

It must always be regarded that, from a dairy standpoint, land devoted to wheat growing represents just so many acres diverted from the principal industry of the farm. The fact that the straw is needed is the only excuse for growing wheat on most dairy farms and is largely the reason that it is grown on many farms not devoted exclusively to dairying. With the prices that have prevailed for wheat the greater part of the time, during the last few years, together with the expense for fertilizer, wheat has not been considered a money producer in the Eastern States.

It was largely to determine the availability of different substitutes for wheat straw, that the work herein recorded was undertaken. Several points must be taken into consideration in any discussion of the suitability of a material for bedding, and it is somewhat difficult to place these in the order of their importance. A great many farmers would unhesitatingly select the bedding that would cost the least in the long run; but, while the cost is undoubtedly one of the chief considerations, there are others perhaps as important.

Bedding is used chiefly to keep animals clean, and the material that will do this the most satisfactorily, other things being equal, is the best. Next, in order, to keeping the animals clean, is the value of the material as an absorbent of the liquid manures. All bedding materials do not possess this property in the same degree, but it is an important consideration and will determine largely the amount of bedding required. Especially is this true with cows. Where gutters behind cows are used, all the bedding needed would be enough to keep the cows clean and comfortable, as the manure drops into the gutter. It is almost needless to enter upon any discussion of the need of preserving the liquid manure by means of an absorbent. It represents a large portion of the value of the manure produced by an animal. The land in the eastern states is badly in need of the elements contained in the manure and also of the humus of the bedding; and bedding material for absorbing the liquid manure is about as important as when intended only for keeping the cows clean. This is one feature in the use of bedding that has not been very generally recognized, especially among dairymen. Where there is a gutter behind the cows to catch and drain off the liquid manure. the unabsorbed material does not interfere with the cleanliness of the herd. As horses are usually stabled it is a different problem for it is necessary to furnish plenty of bedding to absorb all liquid or the horses will not be kept clean.

Another item to be considered in connection with bedding is its cleanliness. Especially is this true with bedding for dairy cows. Any dirt in the material used will find its way into the milk to a greater or less extent. Most bedding materials naturally carry some dust, and as a general proposition the more dusty the straw the more unsatisfactory is it for use with a dairy herd. Straw which has become wet and has moulded is very unsatisfactory material where clean milk is desired. It contains many things that may seriously affect the keeping quality and wholesomeness of the milk. Often dead weeds are raken from the field and used for bedding. This is hardly to be recommended, as so much dust is gathered up with the weeds as to make them unfit for use. Contrary to general opinion and practice, such bedding would be more satisfactory for the horses than for the cows. The dust does not injure the animal in any way, it is objectionable in the dairy stable because it is likely to have a bad effect on the milk, not because it would injure the cows.

But dust and dirt are not the only evils found in different materials used for bedding. Some kinds of straw have a bad effect on the animals. Such is barley, which is not used for bedding because of the beards which irritate the skin of the animal. Bearded wheat has often been objected to for the same reason, though it is doubtful if the objection is well taken.

LIST OF BEDDING TESTS CONDUCTED.

In the work recorded in this bulletin a number of available materials were compared for quantity required to keep the animals clean, and for absorption powers. Wheat straw, uncut, was used as the standard and with this we compared cut wheat straw, cut corn stover, sawdust, and fine shavings from a planing mill. With another lot of cows and with the station horses a comparison was made between wheat straw and green rye straw, both cut and uncut. In this work with the cows there was a gutter behind the cows, and just sufficient bedding was used to make the cows comfortable and keep them clean. No attempt was made to absorb all the liquid. The absorption trials were made in the laboratory, but there is no reason why they should not apply in practice.

COMPARISON OF WHOLE AND CUT STRAW FOR BEDDING.

For the whole straw and cut straw tests, and for the straw and cut stover tests the herd of eighteen cows was divided into two equal lots. A preliminary period of two days was run to get the kind of bedding used thoroughly established when the regular test of ten days was carried through. The character of the bedding was then reversed with the two lots and another preliminary period of two days followed by the regular period of ten days was then carried through. The cows were turned out of the stable for eight hours per day, though it is doubtful if the quantity of bedding required would have been materially increased had they been kept in the stable for the entire twenty-four hours. This would not be true, however, where the quantity of bedding is regulated to absorb all the liquid manure. The first test was made comparing cut wheat straw with the uncut straw and Table I gives the results.

TABLE I.

Comparision of Cut and Uncut Wheat-Straw as Bedding for Cows.

Date.	Lot I. Whole Straw Lbs.	Lot II. Cut Straw Lbs.
January 26	16	18
January 27	22	29
January 28	18	22
January 29	15	23
January 30	22	22
January 31	32	38
February 1	18	37
February 2	18	31
February 3	18	40
February 4	19	34

Date.	Lot II. Whole Straw Lbs.	Lot I. Cut Straw Lbs.
February 9	31	24
February 10	24	21
February 11	23	25
February 12	27	31
February 13	30	38
February 14	25	38
February 15	22	23
February 16	26	28
February 17	30	35
February 18	26	33
Total..........	462 lbs.	582 lbs.

In favor of whole straw..........120 lbs.
Whole straw per cow per day.... 2.3 lbs.
Cut straw per cow per day....... 2.9 lbs.

As can be seen from Table I, considerably more of the cut straw was required than of the uncut to keep the cows clean and make them comfortable, that is, to have sufficient straw on the floor to be sure that no part of the animal would come in contact with the floor. Cut straw is generally supposed to be superior to the uncut, but in no way did this appear to be the case in our tests. It is so easily kicked about, that it will not adhere to the floor, and seems to pack down so solidly on the floor that a larger quantity was required for the same results. Then, too, the cows did not seem to keep so clean when the larger quantity of straw was used. Perhaps if an abnormal quantity of the cut straw was used it might prove a little more satisfactory than when not cut, but as the practical farmer would use it, especially when short of bedding for the year, the cut straw has nothing to recommend it, and requires a larger quantity for the same result. Put in figures this amount would vary when used at the rate which it was used at this Station, 1800 lbs. per year per cow for whole straw and 2300 lbs. per cow per year for the cut straw. This difference is worth considering on most dairy farms where there is a chronic shortage of bedding.

COMPARISON OF WHOLE STRAW AND CUT CORN FODDER FOR BEDDING.

The next test was made with whole straw and cut stover. The same cows were divided into two lots, as in the previous test, and the preliminary period of two days and the test period of ten days was carried through as before, when the lots were reversed and the test continued. The stover used for this purpose was ordinary field cured stover, cut in short pieces by a silage cutter and stored in the barn. It is such stover as is usually fed on most of the farms in the State, and, in this case, stover for bedding and for feeding was taken from the same pile. The following table shows the result of the tests:

TABLE II.

Comparison of Whole Straw and Cut Corn Fodder.

Date.	Lot I. Whole Straw Lbs.	Lot II. Cut Stover Lbs.
February 25	25	41
February 26	25	30
February 27	23	30
February 28	24	31
March 1	29	41
March 2	27	33
March 3	29	34
March 4	23	46
March 5	23	32
March 6	29	37
Date.	Lot II. Whole Straw Lbs.	Lot I. Cut Stover Lbs.
March 10	30	36
March 11	22	32
March 12	23	36
March 13	26	38
March 14	28	44
March 15	23	36
March 16	20	39
March 17	19	38
March 18	21	40
March 19	18	37
Total..........	487 lbs.	731 lbs.

In favor of straw................244 lbs.
Whole straw per cow per day.... 2.4 lbs.
Cut Stover per cow per day...... 3.2 lbs.

The table shows that just about one-third more by weight of cut stover was required for bedding than for the uncut straw. As far as we were able to judge the cut stover was a little more desirable bedding than the straw, and, compared with the cut straw, this was even more pronounced. It kept the cows cleaner, and was not so easily shoved back into the gutter. In fact, cut fodder makes a first-class bedding. It is dusty, but no more so than straw.

Many farmers may hesitate at using fodder for bedding. In the minds of most people, fodder is one of the staple forage crops of the farm, and is raised and cared for for feed only. As was mentioned before, feed and bedding were taken from the same pile at the time these tests were made, and it was very good feed too. To use such material for bedding may appear very wasteful. Wheat straw can be used for no other purpose. It is valueless as feed, and we have come to regard it as a bedding material. But a few comparisons may put the matter in a different light. As was stated, the cut stover makes a more satisfactory bedding than the straw. Now the question comes as to its cost. There are but two ways to get at this. The market price of good wheat straw is a little more than that of fodder per ton. In fact, this difference in selling value is about sufficient to balance the difference in the weights of straw and fodder necessary for the same results in bedding. Another way to compare the two is to consider the amounts grown per acre. Good wheat will make about two tons of straw per acre. But a good crop of fodder is much more sure than is a good crop of straw, and a person depending on corn fodder for bedding is not so likely to be disappointed as when depending on wheat straw. Of course there are other factors to be considered. A corn crop is surer and more valuable than a wheat crop. But, on the other hand, with the present system of farming, wheat is thought necessary as a nurse crop for grass. But what we were trying to establish was that it was not necessary or even advisable to grow wheat purposely for bedding. Corn fodder is as good or better, is a surer crop, and is a more valuable crop otherwise than wheat. It should take the place of wheat straw for bedding to a great extent.

COMPARISON OF SAWDUST AND SHAVINGS FOR BEDDING.

Other materials tried for bedding were sawdust and shavings. The sawdust was obtained from a nearby saw-mill, and was from green logs. It was, of course, very moist. In fact, it would be very difficult to get sawdust that was not very wet as it is usually from green logs, and no attempt is made to keep the rain off. It takes up water very easily and dries out very slowly. The shavings were from a planing mill and were evidently made up largely of well-seasoned pine. In the tests made with these two materials the herd was not divided up into lots as with the straw and fodder. First the sawdust was used through a preliminary period of two days, with the whole herd of eighteen cows, and then the regular ten day test was carried through. The test with shavings was carried through similarly to that with sawdust. Table III shows the results of these tests:

TABLE III.

Comparison of Sawdust and Shavings for Bedding.

Date.	Sawdust.	Date.	Shavings, lbs.
April 9	215	April 22	31
April 10	200	April 23	97
April 11	230	April 24	60
April 12	200	April 25	40
April 13	190	April 26	55
April 14	195	April 27	33
April 15	180	April 28	75
April 16	170	April 29	39
April 17	210	April 30	45
April 18	190	May 1	62
Total	1980	Total	537
Per cow, per day, 11 lbs.		Per cow, per day, 2.7 lbs.	

The test with the sawdust shows that 11 lbs. per cow, per day, were required. Compared with the weights of straw and fodder needed, this seems an unusually large amount; the bulks were about the same.

It is not likely that sawdust is available in many localities, but where it can be procured it will cost about one cent per hundred pounds which makes it a comparatively cheap bedding. A table (See page 9) will be given showing the comparative costs of the different materials used. It must be said that the sawdust, everything considered, was the most satisfactory of the materials used in these tests. It kept the cows cleaner than anything else and staid in place better, as it is not as easily shoved around as was the straw and stover. It can be made to look cleaner and neater than either of the other materials and, unlike the straw and stover, is entirely free from dust. The only possible objection that could be urged against it is that it carries so much moisture as to make it a little damp, but it is very doubtful if this has any bad effect. The sawdust from the pitch pines of the Southern States is said to have a bad effect on the sandy soils of that section. The sawdust decays slowly and has a tendency to loosen up a soil already too loose. This objection would hardly hold good outside of the pitch pine regions or on clay land. Sawdust manure is ideal for scattering on fields.

Practically all that can be said in favor of the sawdust is true of the shavings, and it is also quite dry. It is without the objectionable dust of straw and stover. It makes a fine appearance. The only objection is that it is light and a strong breeze blowing through the stable is likely to scatter it, but, ordinarily, it stays under the cows well and is not easily shoved about. The shavings used come bailed and cost about six to seven dollars per ton in car lots. The test shows that it would require about 1,100 pounds per cow for a year.

For the strictly sanitary dairy, sawdust or shavings are the ideal bedding materials, though the ordinary dairy farmer could not be advised to buy when he could raise either the straw or the stover. There is a little dust in shavings, but it would have no effect on the wholesomeness of the milk, as the dust from the shavings is generally small particles of wood and seldom contains any moulds or bacteria. As was stated before the sawdust is damp and has no dust. Moreover, both of these materials keep the cows cleaner and make a stable look neater than either the straw or the stover.

RYE STRAW.

In the city markets rye straw sells for about twice as much as any other material intended for bedding. Of course it is intended almost exclusively for horses, and the double price paid for it would indicate that horsemen considered it just twice as desirable for bedding. It is a little difficult to get at the true reason. Farmers evidently prefer the wheat straw for both horses and cows. It is very doubtful if rye straw would prove at all satisfactory in a dairy stable. It is hard and stiff and, in some tests made at this station, with a separate and smaller herd than the one used in the previous tests, about the same quantity of rye straw as of wheat straw was used, but the cows did not keep in as clean a condition. The rye straw apparently was a very poor absorbent.

ABSORPTION TESTS.

As was stated, some laboratory tests were made of the amount of moisture each of the materials used was capable of absorbing. As suggested, this was one of the principal qualities affecting the real value of any bedding material and, under most conditions, the quantity of bedding used would need to be regulated largely by its absorbing properties.

According to different tests, a cow will produce from about eight to ten pounds of urine in a day and a horse about half of this quantity. A cow may stand in the stable for the entire twenty-four hours or she may stand but about sixteen hours. As far as is known there have never been any records collected of the proportionate amount of urine, voided during the night, and the day, but it is safe to reason that fully a third of the entire quantity would be during the eight hours that the cow was out of doors.

Table IV shows the absorption power of each of the materials used in the bedding tests, and also the number of pounds of each required to absorb the estimated amount of liquid manure with the cost of bedding.

TABLE IV.

Showing Absorptive Properties and Relative Cost of Different Bedding Materials.

Material.	Water absorbed per lb. of bedding.	Lbs. of bedding required to absorb liquid manure from 1 cow 16 hrs.	Lbs. of bedding required to absorb for 24 hrs.	Yearly cost for cow stabled 16 hrs. per day.	Yearly cost for cow stabled 24 hrs. per day.
Cut Stover....	2.5 lbs.	2.8 lbs.	4.0 lbs.	$ 2.55	$ 3.65
Cut Wheat Straw.	2.0	3.3	5.0	3.61	4.82
Uncut Wheat Straw.	2.0	3.3	5.0	3.11	4.15
Sawdust.	0.8	8.3	12.5	.11	.45
Shavings	2.2	3.0	4.4	3.28	4.81

The prices assumed in Table IV for these different materials would, of course, vary considerably in different seasons and different localities. The cut stover was valued at $5.00 per ton, the uncut straw at $5.00 per ton, the sawdust at 20 cts. per ton, and the shavings at $6.00 per ton. It costs about one dollar per ton to cut straw and a little less to cut the stover. Stover uncut was valued at $4.00 per ton. These were about the relative values on the farm, basing the calculation on the selling price in this section. It will be seen that at the relative prices given cut stover was much more economical than was the uncut straw, and the uncut straw more economical than the cut straw. The shavings cost practically the same as the cut straw. But the shavings were so much more satisfactory, in every other way, that they would more than compensate for the extra cost. Especially is this true where any effort is being made to produce first-class milk.

The relative cost of the sawdust presents an interesting feature. This sawdust was purchased from a nearby sawmill and the cost assumed for the calculations given was the price paid at the mill twenty-five cents per load; it might have been well to consider the cost of hauling which was fifty cents per load. Even this could have been added to the assumed price and still made the sawdust by far the cheapest bedding used. Then, too, as was emphasized before, the sawdust was ideal for this purpose. The conclusion is evident that wherever sawdust can be obtained it would pay to use it for bedding. This would be true even when plenty of corn stover or straw was at hand, for the straw and the stover could be sold and money saved in buying the sawdust.

THE MARYLAND
AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 105. AUGUST, 1905.

EXPERIMENTS WITH FUMIGATING NURSERY STOCK.

By T. B. Symons and A. B. Gahan.

Owing to the fact that some doubt seems to exist among horticulturists throughout the State as to the physiological effect of hydrocyanic acid gas upon nursery trees, it was deemed advisable to undertake further experiments to demonstrate more fully that there is no danger of injuring young trees by fumigation, where reasonable care is exercised in the operation.

GENERAL CONDITION AND DIRECTIONS FOR FUMIGATION.

The general adoption, in the Eastern States, of the principle of fumigation as a means of preventing the distribution, on nursery stock, of the San Jose scale, Woolly aphis, etc., has proven of vast benefit to the fruit industry of these States. While fumigation cannot be considered an absolute guarantee that the nursery stock is entirely free from insect pests, it is undoubtedly the most efficient and at the same time most economical method of treating such infested stock as may have escaped the notice of the nursery inspectors. The efficiency of fumigation, however, depends upon the care exercised in the operation, the purity of chemicals, and the tightness of the apparatus used. It is therefore very important that each nursery should have a thoroughly competent man, whose duty it is to carefully examine all trees before fumigation, conduct the work and see that the roots of such trees are not unduly exposed either before or after the operation, as no doubt many of the injuries attributed to the action of the gas, are due to the careless treatment of the trees before and after fumigation. It is a well-known fact that the careless fumigation of young trees early in the fall, before they have thoroughly ripened or late in the spring, after they have put out, or the exposure of the trees to the gas when they are wet, or the use of a greater amount of chemicals than necessary will result in more or less injury to the trees. These are points with which each nurseryman should be familiar and his own interest should prompt him to have a competent man in charge of the fumigatorium.

Inasmuch as a full discussion of the method of making hydrocyanic acid gas is given in Bulletin No. 75 of this Station, which can be had for the asking, it is only necessary to state briefly that the gas is made by combining potassium cyanide, (98-99 per cent), sulphuric acid (specific gravity 1.83), and water, according to the formula: one ounce of cyanide, two fluid ounces of sulphuric acid, and four fluid ounces of water to every 100 cubic feet of air space. The stock to be fumigated should be exposed for thirty to forty minutes in this gas. While many different formulas have been recommended by various entomologists, the members of the Association of Horticultural Inspectors, at their last meeting, agreed to adhere to the above. The gas can be made by using different proportions of sulphuric acid and water, yet the above formula apparently gives the best results, and is one of the most convenient to calculate.

After calculating the amount of chemicals for a given space, always combine them in an earthen vessel of about a gallon capacity, dividing the materials proportionately so as not to have more than a pound of cyanide for each jar. If more than one jar is used distribute them evenly in a given space. Place in the jar the amount of acid, pour in the water and lastly drop in the cyanide, which is best handled in a paper bag. As a means of safety to the operator each bag should be suspended by a string over the jar containing the liquid. The string can be so arranged that it can be passed to the outer door, from which point all the bags are lowered at the same time into the liquids. The door is then closed and no one is allowed to enter.

After the required time the windows and door of the fumigatorium or house should be opened and the building allowed to air at least fifteen or twenty minutes before anyone enters. The odor of the gas is decidedly that of peach pits and is easily detected. *It is one of the most deadly gases know and means sure death to any animal inhaling it.* For this reason one cannot be too careful in making it, but if directions are followed and due care exercised there is no danger.

The formula given above for fumigation is intended to be used in fumigating all deciduous fruit trees over three feet in height, while dormant. It is not advisable to use that strength for small, weakly trees, June buds, grafts, scions and buds. For stock of this character, .16 to .18 grams cyanide per cubic foot is recommended at the exposure of one-half an hour. Evergreens are usually exempt from pests requiring fumigation.

FUMIGATION EXPERIMENTS.

In this work 3000 nursery trees were used, 1500 of which were fumigated in the fall, these being among the first dug by the nurserymen for their fall shipments. The remaining 1500 were fumigated in the spring, at the time when the spring shipments were being made from the nurseries. It was our intention to have the spring tests a duplication of those in the fall, but owing to the fact that the nursery-

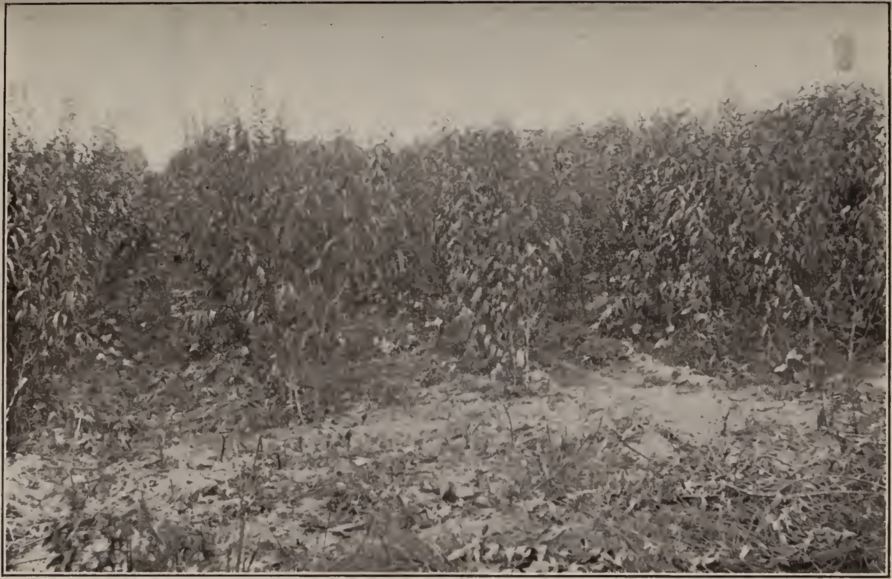

FIGURE 1. GENERAL VIEW OF EXPERIMENTAL PLATS.

men were unable to furnish some of the varieties of trees used in the fall work, it became necessary to substitute others as closely related as possible. It should be stated that in conducting these experiments, particular care was taken that all trees in each experiment received the same treatment as to handling, etc., to which the ordinary shipments are subjected by careful nurserymen. All the trees were treated in the fumigatoriums at the nurseries from which they were secured. These houses were all of regulation construction. The amount of cyanide per cubic foot varied from below normal to six times the amount ordinarily recommended for fumigating such nursery stock. Also one half the trees were fumigated with the varying strengths of cyanide for thirty minutes exposure, and the other half for sixty minutes exposure.

We were unfortunately unable to secure, at the desired time, a plot of ground on the Station farm, all of which was suitable for planting trees. The plot employed contained a considerable strip of red clay soil, very poorly drained, and this no doubt was responsible for the death and weakly condition of the various trees planted throughout that strip. At time of planting, this was exceedingly wet, so much so as to make it impossible to pack the soil properly around the roots, and therefore a spell of dry weather in early spring had a decidedly injurious effect upon the trees. This, combined with the severeness of the past winter, changed somewhat the ultimate number of live and dead trees. It may also be stated that the check plots were located under more favorable soil conditions than many of the treated plots.

It was our intention to include as an additional experiment a large number of different kinds of trees infested with the San Jose scale. However, we were able to obtain only about thirty apple trees that were infested.

In the following tables will be found all the different experiments employed, stating the strengths of cyanide used; time of exposures. and the final condition of the trees.

TABLE I.

SHOWING THE RESULTS OF THE FUMIGATION OF NURSERY STOCK IN THE FALL.

Ten Trees of Each Variety Used in Each Experiment.

(Trees Fumigated on October 15th, and Planted October 25th, 1904).

Kind of Trees and Variety.	No. Trees Started to Grow May 22, 1905.	No. Trees Alive August 18, 1905.	General Condition.
EXPERIMENT No. 1. EXPOSED FOR 30 MINUTES. 0.20 GRAMS* CYANIDE PER CU. FT.			
PEACH:			
Elberta	10	10	All vigorous.
Wheatland	10	10	All vigorous.
Crawford's Early	10	10	All vigorous.
Mt. Rose	9	4	Unfavorable soil (see p. 14).
Smock	10	10	All vigorous.
APPLE:			
Yellow Transparent	10	10	All vigorous.
Ben Davis	10	10	All vigorous.
Maiden Blush	7	7	All vigorous.
York Imperial	10	7	Unfavorable soil (see p. 14).
Winesap	10	8	Unfavorable soil (see p. 14).
EXPERIMENT No. 2. EXPOSED FOR 1 HOUR. 0.20 GRAMS CYANIDE PER CU. FT.			
PEACH:			
Elberta	10	10	All vigorous.
Wheatland	9	10	All vigorous.
Crawford's Early	9	10	All vigorous.
Mt. Rose	10	10	All vigorous.
Smock	10	10	All vigorous.
APPLE:			
Yellow Transparent	10	10	All vigorous.
Ben Davis	10	10	All vigorous.
Maiden Blush	9	10	All vigorous.
York Imperial	10	10	All vigorous.
Winesap	10	10	All vigorous.

*One Ounce = 28.3 Grams.

TABLE I.—CONTINUED.

SHOWING THE RESULTS OF THE FUMIGATION OF NURSERY STOCK IN THE FALL.

Ten Trees of Each Variety Used in Each Experiment.

(Trees Fumigated on October 15th, and Planted October 25th, 1904.)

Kind of Trees and Variety.	No. Trees Started to Grow May 22, 1905.	No. Trees Alive August 18, 1905.	General Condition.
EXPERIMENT NO. 3. EXPOSED FOR 30 MINUTES. 0.30 GRAMS CYANIDE PER CU. FT.			
PEACH:			
Elberta	10	10	All vigorous.
Wheatland	10	10	All vigorous.
Crawford's Early	10	10	Weak; unfavorable soil (see p.14)
Mt. Rose	9	9	Weak; unfavorable soil (see p.14)
Smock	10	9	Weak; unfavorable soil (see p.14)
APPLE:			
Yellow Transparent	10	10	All vigorous.
*Ben Davis	20	18	Weak; unfavorable soil (see p.14)
Maiden Blush			
York Imperial	10	8	All vigorous.
Winesap	10	10	All vigorous.
EXPERIMENT NO. 4. EXPOSED FOR 1 HOUR. 0.30 GRAMS CYANIDE PER CU. FT.			
PEACH:			
Elberta	10	10	All vigorous.
Wheatland	7	10	All vigorous. Three late starting.
Crawford's Early	10	10	All vigorous.
Mt. Rose	10	10	All vigorous.
Smock	10	10	All vigorous.
APPLE:			
Yellow Transparent	10	10	All vigorous.
Ben Davis	10	10	All vigorous.
Maiden Blush	9	10	All vigorous. One late starting.
York Imperial	5	9	All vigorous. Four late starting.
Winesap	10	10	All vigorous.

*Used twenty trees of this variety.

TABLE I.—CONTINUED.

SHOWING THE RESULTS OF THE FUMIGATION OF NURSERY STOCK IN THE FALL.

Ten Trees of Each Variety Used in Each Experiment.

(Trees Fumigated October 15th, and Planted October 25th, 1904.)

Kind of Trees and Variety.	No. Trees Started to Grow May 22, 1905.	No. Trees Alive August 18, 1905.	General Condition.
EXPERIMENT NO. 5, EXPOSED FOR 30 MINUTES. 0.40 GRAMS CYANIDE PER CU. FT.			
PEACH:			
Elberta	10	10	All vigorous.
Wheatland	10	10	All vigorous.
Crawford's Early	10	10	All vigorous.
Mt. Rose	8	9	All vigorous. One late starting.
Smock	10	10	All vigorous.
APPLE:			
Yellow Transparent	10	10	All vigorous.
Ben Davis	10	9	All vigorous.
Maiden Blush	10	9	All vigorous.
York Imperial	10	9	All vigorous.
Winesap	9	7	All vigorous.
EXPERIMENT NO. 6. EXPOSED FOR 1 HOUR. 0.40 GRAMS CYANIDE PER CU. FT.			
PEACH:			
Elberta	10	10	All vigorous.
Wheatland	9	10	All vigorous. One late starting.
Crawford's Early	9	10	All vigorous.
Mt. Rose	10	10	All vigorous.
Smock	9	10	All vigorous.
APPLE:			
Yellow Transparent	10	10	All vigorous.
Ben Davis	10	10	All vigorous.
Maiden Blush	9	10	All vigorous. One late starting.
York Imperial	8	7	All vigorous.
Winesap	10	10	All vigorous.

TABLE I.—CONTINUED.

SHOWING THE RESULTS OF THE FUMIGATION OF NURSERY STOCK IN THE FALL.

Ten Trees of Each Variety Used in Each Experiment.

(Trees Fumigated on October 15th, and Planted October 25th, 1904.)

Kind of Trees and Variety.	No. Trees Started to Grow May 22, 1905.	No. Trees Alive August 18, 1905.	General Condition.
EXPERIMENT NO. 7. EXPOSED FOR 30 MINUTES. 0.50 GRAMS CYANIDE PER CU. FT.			
PEACH:			
Elberta	10	10	All vigorous.
Wheatland	10	10	All vigorous.
Crawford's Early	10	10	All vigorous.
Mt. Rose	10	6	Unfavorable soil (see p. 14)
Smock	8	10	All vigorous. Two late starting.
APPLE:			
Yellow Transparent	10	10	All vigorous.
Ben Davis	10	7	All vigorous.
Maiden Blush	10	10	All vigorous.
York Imperial	9	8	All vigorous.
Winesap	10	7	Unfavorable soil (see p. 14)
EXPERIMENT NO. 8. EXPOSED FOR 1 HOUR. 0.50 GRAMS CYANIDE PER CU. FT.			
PEACH:			
Elberta	10	10	All vigorous.
Wheatland	9	10	All vigorous except one.
Crawford's Early	10	10	All vigorous.
Mt. Rose	10	10	All vigorous.
Smock	10	10	All vigorous.
APPLE:			
Yellow transparent	10	10	All vigorous.
Ben Davis	10	10	All vigorous.
Maiden Blush	10	10	All vigorous except one.
York Imperial	9	10	All vigorous.
Winesap	10	10	All vigorous.

TABLE I.—CONTINUED.

SHOWING THE RESULTS OF THE FUMIGATION OF NURSERY STOCK IN THE FALL.

Ten Trees of Each Variety Used in Each Experiment.

(Trees Fumigated on October 15th, and Planted October 25th, 1904.)

Kind of Trees and Variety.	No. Trees Started to Grow May 22, 1905.	No. Trees Alive August 18, 1905.	General Condition.
EXPERIMENT NO. 9. EXPOSED FOR 30 MINUTES. 0.75 GRAMS CYANIDE PER CU. FT.			
PEACH:			
Elberta	10	10	All vigorous.
Wheatland	9	10	Weak. One late starting.
Crawford's Early	9	10	Fairly vigorous.
Mt. Rose	10	10	Fairly vigorous.
Smock	10	10	Fairly vigorous.
APPLE:			
Yellow Transparent	10	10	All vigorous.
*Ben Davis	9	9	All vigorous.
Maiden Blush	10	10	All vigorous.
York Imperial	9	9	All vigorous.
Winesap	10	10	All vigorous.
EXPERIMENT NO. 10. EXPOSED FOR 1 HOUR. 0.75 GRAMS CYANIDE PER CU. FT.			
PEACH:			
Elberta	10	10	All vigorous.
Wheatland	10	10	All vigorous.
Crawford's Early	10	10	All vigorous.
Mt. Rose	9	10	All vigorous. One late starting.
Smock	10	10	All vigorous.
APPLE:			
Yellow Transparent	10	10	All vigorous.
Ben Davis	7	5	One weak; four vigorous.
Maiden Blush	10	7	Two weak; five vigorous.
York Imperial	7	5	One weak; four vigorous.
Winesap	8	3	All vigorous.

*Used nine trees of this variety in this test.

TABLE I.—CONTINUED.

SHOWING THE RESULTS OF THE FUMIGATION OF NURSERY STOCK IN THE FALL.

Ten Trees of Each Variety Used in Each Experiment.

(Trees Fumigated on October 15th, and Planted October 25th, 1904.)

Kind of Trees and Variety.	No. Trees Started to Grow May 22, 1905.	No. Trees Alive August 18, 1905.	General Condition.
EXPERIMENT NO 11. EXPOSED FOR 30 MINUTES. 1 GRAM CYANIDE PER CU. FT.			
PEACH:			
Elberta	10	10	All vigorous.
Wheatland	7	8	Two weak; six vigorous.
Crawford's Early	9	8	All vigorous.
Mt. Rose	10	10	All vigorous.
Smock	7	10	All vigorous; three late starting.
APPLE:			
Yellow Transparent	10	10	All vigorous.
Ben Davis	10	10	All vigorous.
Maiden Blush	10	10	All vigorous.
York Imperial	10	8	All vigorous.
Winesap	10	10	All vigorous.
EXPERIMENT NO. 12. EXPOSED FOR 1 HOUR. 1 GRAM CYANIDE PER CU. FT.			
PEACH:			
Elberta	10	10	All vigorous.
Wheatland	10	10	All vigorous.
Crawford's Early	10	9	All vigorous.
Mt. Rose	9	10	All vigorous.
Smock	10	10	All vigorous.
APPLE:			
Yellow Transparent	10	10	All vigorous.
Ben Davis	9	8	All vigorous.
Maiden Blush	5	2	Apparently injured by gas.
York Imperial	6	1	Apparently injured by gas.
Winesap	5	2	Apparently injured by gas.

TABLE I.—CONTINUED.

SHOWING THE RESULTS OF THE FUMIGATION OF NURSERY STOCK IN THE FALL.

Ten Trees of Each Variety Used in Each Experiment.

(Trees Fumigated on October 15th, and Planted October 25th, 1904.)

EXPERIMENT No. 13. EXPOSED FOR 30 MINUTES. 1.50 GRAMS CYANIDE PER CU. FT.

Kind of Trees and Variety.	No. Trees Started to Grow May 22, 1905.	No. Trees Alive August 18, 1905.	General Condition.
PEACH:			
Elberta	10	7	All vigorous.
Wheatland	9	10	All vigorous; one late starting.
Crawford's Early	10	10	All vigorous.
Mt. Rose	10	10	All vigorous.
Smock	8	6	All vigorous.
APPLE:			
*Yellow Transparent	11	11	All vigorous.
Ben Davis	10	10	All vigorous.
Maiden Blush	9	10	All vigorous; one late starting.
York Imperial	9	5	All vigorous.
Winesap	10	10	All vigorous.

*Used eleven trees of this variety in this test.

EXPERIMENT No. 14. EXPOSED FOR 1 HOUR. 1.50 GRAMS CYANIDE PER CU. FT.

Kind of Trees and Variety.	No. Trees Started to Grow May 22, 1905.	No. Trees Alive August 18, 1905.	General Condition.
PEACH:			
Elberta	2	10	All vigorous. Eight late starting.
Wheatland	10	9	All vigorous.
Crawford's Early	10	10	All vigorous.
Mt. Rose	10	10	All vigorous.
Smock	10	10	All vigorous.
APPLE:			
Yellow Transparent	10	7	All vigorous.
†Maiden Blush	7	3	Apparently injured by gas.
York Imperial	5	0	Apparently injured by gas.
Winesap	5	1	Apparently injured by gas.

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*Used twenty trees of this variety in this test.

†Used twenty trees of this variety in this test.

TABLE II.

Showing the Results of the Fumigation of Nursery Stock in the Spring

Ten Trees of Each Variety Used in Each Experiment.

(Trees Fumigated April 7th, and Planted April 18th, 1905).

Kind of Trees and Variety.	No. Trees Started to Grow May 22.	No. Trees Alive August 18.	General Condition.
Experiment No. 1. Exposed for 30 Minutes. 0.20 Grams Cyanide Per Cu. Ft.			
PEACH:			
Kalamazoo	10	10	All vigorous
Weeds Late Barnard	10	10	All vigorous.
Large Early York	10	10	All vigorous.
Early Michigan	10	10	All weak; soil unfavorable (see p. 14)
Red Cheeked Melocoton	10	10	All weak; soil unfavorable (see p. 14)
APPLE:			
Yellow Transparent	10	10	All vigorous.
Ben Davis	10	10	All vigorous.
Maiden Blush	10	10	All vigorous.
York Imperial	10	9	All vigorous.
Winesap	10	10	All weak; soil unfavorable (see p. 14)
Experiment No. 2. Exposed for 1 Hour. 0.20 Grams Cyanide Per Cu. Ft.			
PEACH:			
*Carman	9	9	All vigorous.
Wheatland	10	10	All vigorous.
Crawford's Early	10	10	All vigorous.
Mt. Rose	10	10	All vigorous.
Smock	10	10	All vigorous.
APPLE:			
Early Harvest	10	10	All vigorous.
Ben Davis	10	10	All vigorous.
Maiden Blush	10	10	All vigorous.
York Imperial	9	10	All vigorous.
Winesap	10	10	All vigorous.

*Used nine trees of this variety.

TABLE II.—CONTINUED.

SHOWING THE RESULTS OF THE FUMIGATION OF NURSERY STOCK IN THE SPRING.

Ten Trees of Each Variety Used in Each Experiment.

(Trees Fumigated April 7th, and Planted April 18th, 1905).

Kind of Trees and Variety.	No. Trees Started to Grow May 22.	No. Trees Alive August 18.	General Condition.
EXPERIMENT No. 3. EXPOSED FOR 30 MINUTES. 0.30 GRAMS CYANIDE PER CU. FT.			
PEACH:			
Kalamazoo	10	10	All vigorous.
Weeds Late Barnard	10	10	All vigorous.
Large Early York	10	10	All vigorous.
Early Michigan	10	10	All weak; soil unfavorable (see p. 14)
Red Cheeked Melocoton	10	10	All weak; soil unfavorable (see p. 14)
APPLE:			
Yellow Transparent	10	10	All vigorous.
Ben Davis	10	10	All vigorous.
Maiden Blush	10	10	All vigorous.
York Imperial	10	10	All vigorous.
Winesap	10	10	All vigorous.
EXPERIMENT No. 4. EXPOSED FOR 1 HOUR. 0.30 GRAMS CYANIDE PER CU. FT.			
PEACH:			
Carman	10	10	All vigorous.
Wheatland	10	10	All vigorous.
Crawford's Early	10	10	All vigorous.
Mt. Rose	10	10	All vigorous.
Smock	9	10	All vigorous.
APPLE:			
Early Harvest	10	10	All vigorous.
Ben Davis	10	10	All vigorous.
Maiden Blush	10	10	All vigorous.
York Imperial	10	10	All vigorous.
Winesap	10	10	All vigorous.

TABLE II.—CONTINUED.

SHOWING THE RESULTS OF THE FUMIGATION OF NURSERY STOCK IN THE SPRING

Ten Trees of Each Variety Used in Each Experiment.

(Trees Fumigated April 7th, and Planted April 18th, 1905).

Kind of Trees and Variety.	No. Trees Started to Grow May 22.	No. Trees Alive August 18.	General Condition.
EXPERIMENT NO. 5. EXPOSED FOR 30 MINUTES. 0.40 GRAMS CYANIDE PER CU. FT.			
PEACH:			
Kalamazoo	10	10	All vigorous.
Weeds Late Barnard	10	10	All weak; soil unfavorable (see p. 14)
Large Early York	10	10	All vigorous.
Early Michigan	10	10	All vigorous.
Red Cheeked Melocoton	10	10	All vigorous.
APPLE:			
Yellow Transparent	10	10	All vigorous.
Ben Davis	10	10	All vigorous.
Maiden Blush	10	10	All vigorous.
York Imperial	10	10	All vigorous.
Winesap	10	10	All vigorous.
EXPERIMENT NO. 6. EXPOSED FOR 1 HOUR. 0.40 GRAMS CYANIDE PER CU. FT.			
PEACH:			
Carman	10	10	All vigorous.
Wheatland	10	10	All vigorous.
Crawford's Early	10	10	All vigorous.
Mt. Rose	9	10	All vigorous; one late starting
Smock	10	10	All vigorous.
APPLE:			
Early Harvest	10	10	All vigorous.
Ben Davis	10	10	All vigorous.
Maiden Blush	6	9	All vigorous: four late starting
York Imperial	10	10	All vigorous.
Winesap	9	10	All vigorous; one late starting

TABLE II.—CONTINUED.

SHOWING THE RESULTS OF THE FUMIGATION OF NURSERY STOCK IN THE SPRING.

Ten Trees of Each Variety Used in Each Experiment.

(Trees Fumigated April 7th, and Planted April 18th, 1905).

Kind of Trees and Variety.	No. Trees Started to Grow May 22.	No. Trees Alive August 18.	General Condition.
EXPERIMENT NO. 7. EXPOSED FOR 30 MINUTES. 0.50 GRAMS CYANIDE PER CU. FT.			
PEACH:			
Kalamazoo	10	10	All vigorous.
Weeds Late Barnard	10	10	Some weak; soil unfavorable (see p. 14)
Large Early York	10	10	All vigorous.
Early Michigan	10	10	Some weak; soil unfavorable (see p. 14)
Red Cheeked Melocoton	10	10	All vigorous.
APPLE:			
Yellow Transparent	10	10	All vigorous.
Ben Davis	10	10	All vigorous.
Maiden Blush	10	10	All vigorous.
York Imperial	10	10	All vigorous.
Winesap	10	10	All vigorous.
EXPERIMENT NO. 8. EXPOSED FOR 1 HOUR. 0.50 GRAMS CYANIDE PER CU. FT.			
PEACH:			
Carman	10	10	All vigorous.
Wheatland	7	10	All vigorous; three late starting.
Crawford's Early	10	10	All vigorous.
Mt. Rose	10	10	All vigorous.
Smock	10	10	All vigorous.
APPLE:			
Early Harvest	10	10	All vigorous.
Ben Davis	9	10	All vigorous; one late starting
Maiden Blush	10	10	All vigorous.
York Imperial	10	10	All vigorous.
Winesap	10	10	All vigorous.

TABLE II.—CONTINUED.

SHOWING THE RESULTS OF THE FUMIGATION OF NURSERY STOCK IN THE SPRING.

Ten Trees of Each Variety Used in Each Experiment.

(Trees Fumigated April 7th, and Planted April 18th, 1905).

Kind of Trees and Variety.	No. Trees Started to Grow May 22.	No. Trees Alive August 18.	General Condition.
EXPERIMENT No. 9, EXPOSED FOR 30 MINUTES. 0.75 GRAMS CYANIDE PER CU. FT.			
PEACH:			
Carman	9	10	All vigorous; one late starting.
Wheatland	10	10	All vigorous.
Crawford's Early	10	10	All vigorous.
Mt. Rose	9	10	All vigorous; one late starting
Smock	8	9	All vigorous; one late starting.
APPLE:			
Early Harvest	10	10	All vigorous.
Ben Davis	10	10	All vigorous.
Maiden Blush	10	10	All vigorous.
York Imperial	10	10	All vigorous.
Winesap	7	9	All vigorous; two late starting
EXPERIMENT No. 10, EXPOSED FOR 1 HOUR. 0.75 GRAMS CYANIDE PER CU. FT.			
PEACH:			
Kalamazoo	10	10	All vigorous.
Weeds Late Barnard	10	10	All vigorous.
Large Early York	10	10	All vigorous.
Early Michigan	10	10	All vigorous.
Red Cheeked Melocoton	10	10	All vigorous.
APPLE:			
Yellow Transparent	10	10	All vigorous.
Ben Davis	10	10	All vigorous.
Maiden Blush	10	10	All vigorous.
York Imperial	10	10	All vigorous.
Winesap	10	10	All vigorous.

TABLE II.—CONTINUED.

SHOWING THE RESULTS OF THE FUMIGATION OF NURSERY STOCK IN THE SPRING.

Ten Trees of Each Variety Used in Each Experiment.

(Trees Fumigated April 7th, and Planted April 18th, 1905).

Kind of Trees and Variety.	No. Trees Started to Grow May 22.	No. Trees Alive August 18.	General Condition.
EXPERIMENT NO. 11, EXPOSED FOR 30 MINUTES. 1 GRAM CYANIDE PER CU. FT.			
PEACH:			
Carman	8	10	All vigorous: two late starting
Wheatland	9	10	All vigorous; one late starting,
Crawford's Early	10	10	All vigorous.
Mt. Rose	9	10	All vigorous: one late starting.
Smock	10	10	All vigorous.
APPLE:			
Early Harvest	9	10	All vigorous; one late starting
Ben Davis	6	10	All vigorous; four late starting.
Maiden Blush	3	9	Soil unfavorable (see p. 14): six late starting.
York Imperial	10	10	All vigorous.
Winesap	10	10	All vigorous.
EXPERIMENT NO. 12, EXPOSED FOR 1 HOUR. 1 GRAM CYANIDE PER CU. FT			
PEACH:			
Kalamazoo	10	10	All vigorous.
Weeds Late Barnard	10	10	All vigorous.
Large Early York	10	10	All vigorous.
Early Michigan	10	10	All vigorous.
Red Cheeked Melocoton	10	10	All vigorous.
APPLE:			
Yellow Transparent	10	10	All vigorous.
Ben Davis	10	10	All vigorous.
Maiden Blush	10	10	All vigorous.
York Imperial	10	10	All vigorous.
Winesap	10	10	All vigorous.

TABLE II.—CONTINUED.

SHOWING THE RESULTS OF THE FUMIGATION OF NURSERY STOCK IN THE SPRING.

Ten Trees of Each Variety Used in Each Experiment.

(Trees Fumigated April 7th, and Planted April 18th, 1905).

Kind of Trees and Variety.	No. Trees Started to Grow May 22.	No. Trees Alive August 18.	General Condition.
EXPERIMENT NO. 13. EXPOSED FOR 30 MINUTES. 1.50 GRAMS CYANIDE PER CU. FT.			
PEACH:			
Carman	6	10	All vigorous; four late starting.
Wheatland	9	10	All vigorous; one late starting.
Crawford's Early	10	10	All vigorous.
Mt. Rose	7	10	All vigorous; three late starting.
Smock	10	10	All vigorous.
APPLE:			
Early Harvest	9	10	All vigorous; one late starting
Ben Davis	10	10	All vigorous.
Maiden Blush	9	10	All vigorous; one late starting.
York Imperial	7	10	All vigorous; three late starting.
Winesap	9	10	All vigorous; one late starting.
EXPERIMENT NO. 14. EXPOSED FOR 1 HOUR. 1.50 GRAMS CYANIDE PER CU. FT.			
PEACH:			
Kalamazoo	10	10	All vigorous.
Weeds Late Barnard	10	10	All vigorous.
Large Early York	10	10	All vigorous.
Early Michigan	10	10	All vigorous.
Red Cheeked Melocoton	10	10	All vigorous.
APPLE:			
Yellow Transparent	10	10	All vigorous.
Ben Davis	10	10	All vigorous.
Maiden Blush	10	10	All vigorous.
York Imperial	10	9	All vigorous.
Winesap	10	9	All vigorous.

TABLE III.

Trees not Fumigated and Planted in the Fall for Comparison.

(Ten Trees of Each Variety Planted October 25, 1904).

Kinds of Trees and Variety.	No. Started May 22, 1905.	No. Alive August 18, 1905.	Condition.
PEACH:			
Elberta	10	10	All vigorous.
*Wheatland	5	5	All vigorous.
Crawford's Early	10	10	All vigorous.
Mt. Rose	10	10	All vigorous.
Smock	10	10	All vigorous.
APPLE:			
Yellow Transparent	10	9	All vigorous.
Ben Davis	10	10	All vigorous.
Maiden Blush	10	10	All vigorous.
York Imperial	9	9	All vigorous.
Winesap	10	10	All vigorous.

*Used five trees of this variety.

TABLE IV.

Trees not Fumigated and Planted in the Spring for Comparison.

(Five Trees of Each Variety Planted April 18, 1905).

Kind of Trees and Variety	No. Started May 22, 1905.	No. Alive August 18, 1905.	Condition.
PEACH:			
Carman	5	5	All vigorous.
Wheatland	5	5	All vigorous.
Crawford's Early	5	5	All vigorous.
Mt. Rose	3	5	All vigorous; one late starting.
Smock	5	5	All vigorous.
Red Cheeked Mel	5	5	All vigorous.
Kalamazoo	5	5	All vigorous.
Weeds Late Barnard	5	5	All vigorous.
L. Early York	5	5	All vigorous.
Early Michigan	5	5	All vigorous.
APPLE:			
Yellow Transparent	5	5	All vigorous.
Early Harvest	5	5	All vigorous.
*Ben Davis	10	10	All vigorous.
*Maiden Blush	10	9	All vigorous; one late starting.
*York Imperial	9	10	All vigorous; one late starting.
*Winesap	10	10	All vigorous.

*Used ten trees of these varieties.

DISCUSSION OF RESULTS.

For a full understanding of the results of these experiments, it will be necessary for the reader to carefully compare the tables given. A cursory examination of the tables would indicate that in some cases the trees were injured by the gas, whereas a careful comparison with other experiments where a greater amount of cyanide and a longer exposure was given will prove that the apparently unsatisfactory results were not due to the effect of the gas, but to other agencies. For example, in Experiment 1, of the fall tests, in which twenty hundredths of a gram of cyanide with an exposure of half an hour was employed, fourteen trees failed to live; while in Experiment 2, where the same amount of cyanide, with twice as long exposure, was employed, all of the trees are in a vigorous condition. Also comparisons of Experiments 3 and 4, 5 and 6, 7 and 8, of the fall tests, will give the same deductions. Without doubt the poor showing made by the one-half hour exposure is attributable to the unfavorable soil conditions and severeness of the past winter.

On the other hand, it will be noted in Experiments 9 and 10, 11 and 12, 13 and 14, in which excessive amounts of cyanide were used, that the greater number of dead trees are found under the one hour exposure. The death of these trees we attribute to the effect of the gas. However, it is seen that even with the excessive amounts of cyanide used, in the half hour tests no greater percentage of trees failed to live than is ordinarily the case in orchard planting.

A peculiar feature of the results of the fall experiments is the fact that the peach trees were apparently more resistant to the effect of the gas than were the apple. This result is rather surprising, as at the time the experiments were conducted the apple trees were apparently more mature than the peach, and therefore were expected to be less likely to be injured. This is contrary to the generally accepted opinion and is not observed in the spring tests. We are unable at present to offer a plausible explanation.

It is also observed that apparently some varieties of apple offer a greater resistance to the gas than others, as in the experiments with stronger gas and longer exposure, the Yellow Transparent was uninjured, whereas the other four varieties showed more or less injury.

An examination of the spring experiments shows absolutely no injury from fumigation, even when the excessive strengths and time were employed. In no plot of 100 trees were there over two trees dead, and in the total of 1500 trees treated only seven, which is about five-tenths of one per cent. failed to live.

The trees infested with San Jose scale mentioned above and fumigated simultaneously with the other spring experiments at the normal strength; viz: 1 oz. cyanide, 2 fluid ounces of sulphuric acid and 4 fluid ounces of water to 100 cubic feet of air space, all lived and an examination at this date revealed no live scale present.

SUMMARY.

The results obtained from these experiments on the whole may be considered very satisfactory and may be summarized as follows:

First, That no injury results from fumigating dormant apple and peach nursery stock, two years of age or over, with a strength of cyanide and time of exposure considerably above that ordinarily recommended, where due care is exercised in the operation.

Second, The results demonstrate that there is no danger of injury to nursery stock by proper fumigation at the nursery.

Third, That apparently fumigation of nursery trees in the fall with excessive strengths is more likely to show injury than in the spring.

Fourth, That there is a difference in the resisting power of apple and peach trees, the latter being less injured. Further, that some varieties of apple included in this experiment, viz: Winesap, Ben Davis, Maiden Blush and York Imperial, fumigated in the fall, apparently show less resistance to the effects of the gas than the others used.

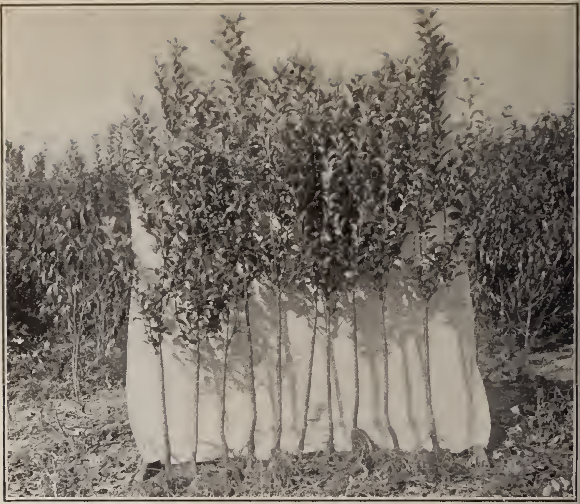

FIGURE 2. YELLOW TRANSPARENT APPLE. FUMIGATED IN THE FALL WITH ONE GRAM CYANIDE PER CUBIC FOOT FOR ONE HOUR, NINE MONTHS AFTER TREATMENT.

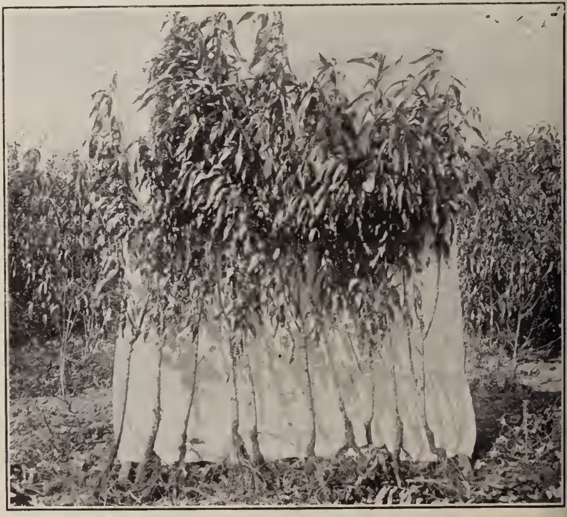

FIGURE 3. WHEATLAND PEACH. FUMIGATED IN THE FALL WITH O GRAM CYANIDE PER CUBIC FOOT FOR ONE HOUR, NINE MONTHS AFT TREATMENT.

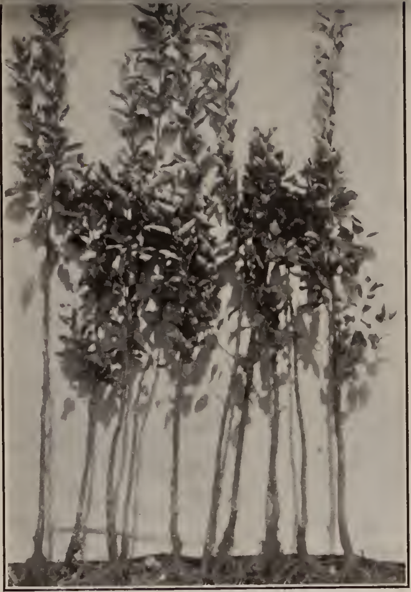

FIGURE 4. MAIDEN BLUSH APPLE. FUMIGATED IN THE SPRING WITH 1.5 GRAMS CYANIDE PER CUBIC FOOT FOR ONE HOUR, FIVE MONTHS AFTER TREATMENT.

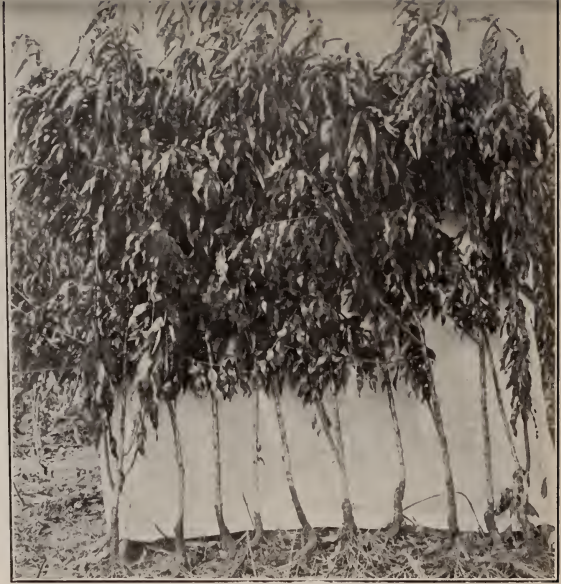

FIGURE 5. EARLY MICHIGAN PEACH. FUMIGATED IN THE SPRING WITH 1.5 GRAMS CYANIDE PER CUBIC FOOT FOR ONE HOUR, FIVE MONTHS AFTER TREATMENT.

THE MARYLAND

AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 106. SEPTEMBER, 1905.

Some Observations on the Weight of the Kernels and the Size of the Germ in Seed Corn as Affecting the Vigor of the Resulting Plant.

By E. P. Walls.

INTRODUCTION.

There has been a diversity of opinion as to whether the vigor of a corn plant is or is not governed in any way by the weight of the kernel, or the size of the germ in the kernel from which it grows. This is an important question. If the lighter kernels, or those having small germs, produce less vigorous plants, we of course should eliminate them from our seed corn, for it is the strongest, hardiest plants that give us the largest and best ears. The object of these experiments was to obtain data from which to deduce a rule of practice in the selection of seed corn, whether we should reject ears bearing kernels of small weight, and small germs, or whether this discrimination is unnecesssary.

EXPERIMENT NO. 1.

To Determine the Relation Between the Weight of the Corn Kernel and the Vigor of the Plant.

Five grains were taken from each of the forty ears to be planted in breeding plots K2, M2, N2 and R1, at the Maryland Experiment Station this year, and these were germinated in sand. K2, M2 and N2 are native Maryland varieties, in the second generation of breeding at this Station. R1 has only been grown here one year, but had been carefully bred and selected in Illinois for a number of years previous. M2 and N2 are white varieties. K2 and R1 are yellow. There was practically no plant food contained in the sand, but by this method of germination the plants attained a sufficient height to show a difference in their growing power. Each of the samples of five kernels each, a total of one hundred and sixty samples, was weighed before being placed in the sand, the idea being to see the relation between the size of the kernel, as determined by the weight, and the vigor of the plant.

The germinating boxes were 22 inches by 12 inches and 2 1-4 inches deep. These were filled with sand to a depth of 2 inches, and the kernels were planted two inches apart each way, giving room for the samples from ten ears to each box, making a total of sixteen boxes. In making the boxes all of them did not fit together in exactly the same way, therefore their water-holding capacity varied slightly, but not enough to materially affect the experiment. The grains were planted and the boxes put in the greenhouse on Thursday, March 9th. They commenced to come up on Wednesday, March 15th, six days after planting.

The average temperature of the greenhouse during this experiment was 60 degrees Farenheit; but it was much higher than this at midday.

Following is a record of the weights given in grammes and fractions thereof.

TABLE 1.

WEIGHT OF GRAINS IN LOT K2

No. of ear.	Total weight of 5 grains.	Average weight in grammes.	No. of ear.	Total weight of 5 grains.	Average weight in grammes.
1	2.018	0.4056	21	2.167	.4334
2	1.616	.3232	22	2.189	.4378
3	1.650	.3300	23	1.637	.3274
4	2.067	.4134	24	1.974	.3948
5	2.006	.4012	25	2.199	.4398
6	2.413	.4826	26	2.052	.4104
7	2.051	.4102	27	2.109	.4218
8	1.811	.3622	28	2.072	.4144
9	1.796	.3592	29	2.060	.4120
10	2.059	.4118	30	2.255	.4510
11	1.819	.3638	31	2.326	.4652
12	1.917	.3834	32	1.863	.3726
13	2.091	.4182	33	1.580	.3160
14	1.875	.3750	34	1.889	.3778
15	1.868	.3736	35	2.434	.4868
16	1.857	.3714	36	1.929	.3858
17	1.711	.3422	37	1.999	.3998
18	1.836	.3672	38	1.759	.3518
19	2.233	.4466	39	1.927	.3854
20	1.967	.3934	40	2.119	.4238
		7.7342			8.1078
		8.1078			

Grand Total............15.8420
Average weight per grain, .3961 grams.

TABLE 2.

WEIGHT OF GRAINS IN LOT M2

No. of ear.	Total weight of 5 grains.	Average weight in grammes.	No. of ear.	Total weight of 5 grains.	Average weight in grammes.
1	2.039	.4078	21	1.857	.3714
2	1.924	.3848	22	1.733	.3466
3	2.273	.4546	23	1.971	.3942
4	1.833	.3666	24	1.943	.3886
5	1.974	.3948	25	1.860	.3720
6	1.752	.3504	26	2.078	.4156
7	2.196	.4390	27	2.191	.4382
8	1.990	.3980	28	2.030	.4060
9	1.990	.3980	29	2.053	.4106
10	2.045	.4090	30	1.878	.3756
11	2.295	.4590	31	1.797	.3594
12	1.708	.3416	32	1.826	.3652
13	1.753	.3506	33	1.678	.3356
14	2.187	.4374	34	1.740	.3480
15	1.781	.3562	35	1.629	.3258
16	2.013	.4026	36	1.908	.3816
17	1.685	.3370	37	1.816	.3632
18	2.208	.4416	38	1.709	.3418
19	2.046	.4092	39	2.066	.4132
20	1.929	.3858	40	1.929	.3858
		7.9242 7.5384			7.5384

Grand Total............15.4626
Average weight per grain, .3866 grams.

TABLE 3.

WEIGHT OF GRAINS IN LOT N2

No. of ear.	Total weight of 5 grains.	Average weight in grammes.	No. of ear.	Total weight of 5 grains.	Average weight in grammes.
1	1.813	.3626	21	2.079	.4138
2	2.136	.4272	22	1.860	.3720
3	1.689	.3378	23	1.760	.3520
4	1.923	.3846	24	1.811	.3622
5	1.531	.3062	25	1.485	.2970
6	1.806	.3612	26	2.060	.4120
7	1.507	.3014	27	1.706	.3412
8	1.834	.3668	28	1.839	.3678
9	1.949	.3898	29	1.783	.3566
10	2.124	.4248	30	1.950	.3900
11	1.874	.3748	31	1.722	.3444
12	2.419	.4838	32	1.555	.3110
13	1.809	.3618	33	1.579	.3158
14	1.801	.3602	34	1.901	.3802
15	1.770	.3540	35	2.004	.4008
16	2.111	.4222	36	2.113	.4226
17	2.050	.4100	37	2.058	.4116
18	1.818	.3636	38	1.824	.3648
19	2.178	.4356	39	1.938	.3876
20	1.851	.3702	40	1.796	.3592
		7.5986 7.3646			7.3646

Grand Total............14.9632
Average weight per grain, .3741 grams.

TABLE 4.

WEIGHT OF GRAINS IN LOT R1

No. of ear.	Total weight of 5 grains.	Average weight in grammes.	No. of ear.	Total weight of 5 grains.	Average weight in grammes.
1	1.565	.3130	21	2.080	.4160
2	1.926	.3852	22	1.778	.3556
3	1.735	.3470	23	1.785	.3570
4	1.809	.3618	24	1.639	.3278
5	1.672	.3344	25	1.735	.3470
6	1.577	.3154	26	1.599	.3198
7	1.765	.3530	27	1.805	.3610
8	1.847	.3694	28	1.785	.3570
9	1.792	.3584	29	1.710	.3420
10	1.624	.3248	30	1.678	.3356
11	1.588	.3076	31	1.769	.3538
12	1.687	.3374	32	1.605	.3210
13	1.661	.3322	33	1.779	.3558
14	1.943	.3886	34	2.121	.4242
15	1.911	.3822	35	1.887	.3774
16	1.689	.3378	36	1.776	.3552
17	2.375	.4750	37	1.767	.3534
18	2.557	.5114	38	1.529	.3058
19	1.883	.3766	39	1.497	.2994
20	1.984	.3968	40	1.552	.3104
		7.3180			6.9752
		6.9752			

Grand Total............14.2932
Average weight per grain, .3573 grams.

The following are the average dimensions of the ears in the respective lots.

	Munnikuysen. M2.	Leaming. R1.	Garner. K2	St. Omer White. N2.
Average length of grains in inches....	.481	.493	.456	.443
Average circum. of ears in inches......	7.4	7.8	6.7	7.0
Average number of rows..............	16.6	19.3	14.9	16.2
Average weight per grain in grams....	.387	.357	.396	.374

From the fact that the grains from K2 are heavier, it might be inferred that they are larger but by a glance at the above dimensions it will be found that K2 ranks third in length of grain and fourth in circumference of ears and number of rows, showing that the ears are smaller, and although there is a smaller number of rows, the grains are not so broad or certainly not broader than the grains from any of the other breeding lots. Then, if K2 has a smaller grain, why is it the heaviest? Because it is more of a flinty type than any of the others. R1 gives the lowest average weight, although it has the largest grain, because it is of a pronounced dent type, with a slight inclination to become chaffy. The flinty types of grain are relatively heaviest.

The following notes were taken on the growth of the grains in the germinating boxes with their respective dates. After the first set of notes were taken on Tuesday and Wednesday, March 21st and 22nd, the germinating boxes received no water until after the second set of notes were taken on March 26th, on which date the water was applied again, and daily thereafter. The last set of notes was taken on April 3rd, one week after water had been applied to the boxes again. The object of this was to compare the vitality of the plants under condition of drought, and the last set of notes, bearing the date of April 3rd, shows which revived most quickly on having a subsequent supply of moisture.

TABLE NO. 5, LOT M2.

Showing the condition of the plants in the several boxes, March 21st, 1905, 12 days after planting.

	No. of row.	Plants up.	IN INCHES. Height of tallest.	Height of smallest.	Average height.	Plants vigorous.	Plants weak.	Plants green.	Plants light colored.	Greatest number leaves.	Smallest number leaves.	Average number leaves.	Plants with diseased leaves.	Plants wilting.
	1	5	5.7	3.5	4.60	5	0	5	0	3	2	2.5	2	0
	2	5	6.2	4.6	5.40	5	0	5	0	3	3	3.0	0	0
	3	5	4.9	3.8	4.33	4	1	5	0	3	2	2.5	1	4
	4	5	4.7	2.9	3.75	4	1	5	0	3	2	2.5	2	0
Box 1.	5	5	5.4	3.3	4.35	2	3	5	0	3	2	2.5	1	3
	6	5	4.2	2.1	3.15	1	4	4	1	2	2	2.0	0	0
	7	5	5.2	2.3	3.75	3	2	5	0	3	2	2.5	0	0
	8	5	4.2	1.1	2.65	1	4	5	0	2	2	2.0	0	0
	9	5	4.7	2.7	3.70	4	1	4	1	3	2	2.5	0	0
	10	5	5.5	3.0	4.00	4	1	5	0	3	2	2.0	1	0
	11	5	5.7	3.0	4.35	4	1	5	0	3	2	2.5	0	0
	12	4	6.6	1.3	3.95	3	1	4	0	3	2	2.5	0	1
	13	5	5.1	3.5	4.30	2	3	5	0	3	2	2.5	0	0
	14	5	5.2	4.3	4.75	5	0	5	0	3	3	3.0	0	0
Box 2.	15	5	4.9	2.5	3.70	3	2	4	1	3	2	2.5	0	0
	16	5	5.3	4.5	4.90	5	0	5	0	3	3	3.0	0	0
	17	5	5.6	4.2	4.90	5	0	5	0	3	3	3.0	0	0
	18	5	4.2	2.9	3.55	5	0	5	0	3	3	3.0	0	0
	19	5	5.3	4.2	4.75	5	0	5	0	3	3	3.0	0	0
	20	5	5.2	2.7	3.85	4	1	5	0	3	3	3.0	0	0
	21	5	5.8	2.1	3.85	3	2	5	0	3	2	2.5	0	0
	22	5	4.5	2.6	3.55	3	2	5	0	3	3	3.0	0	0
	23	5	4.4	3.11	3.75	5	0	5	0	3	2	2.5	0	0
	24	5	4.8	2.9	3.85	3	2	5	0	3	2	2.5	0	0
Box 3.	25	5	3.5	1.3	2.40	0	5	5	0	3	2	2.5	0	0
	26	5	4.3	3.0	3.65	4	1	5	0	3	2	2.5	0	0
	27	5	4.7	4.0	1.35	5	0	5	0	3	3	3.0	0	0
	28	5	5.0	3.8	4.40	5	0	5	0	3	2	2.5	0	0
	29	5	4.6	2.2	3.10	1	4	5	0	3	2	2.5	0	0
	30	5	4.2	3.1	3.65	4	1	5	0	3	2	2.5	0	0
	31	5	4.2	1.8	3.00	3	2	5	0	3	2	2.5	0	0
	32	5	4.3	2.9	3.60	5	0	5	0	3	3	3.0	0	0
	33	5	4.3	3.3	3.30	5	0	5	0	3	2	2.5	0	0
	34	5	4.2	2.6	3.40	3	2	5	0	3	2	2.5	0	0
Box 4.	35	4	4.3	2.8	3.55	3	1	4	0	3	2	2.5	0	0
	36	5	3.5	2.5	3.00	2	3	5	0	3	2	2.5	0	0
	37	5	4.0	1.0	2.50	1	4	5	0	3	2	2.5	0	0
	38	5	4.2	2.6	3.40	3	2	5	0	3	2	2.5	0	0
	39	5	5.0	3.3	4.15	5	0	5	0	3	3	3.0	0	0
	40	5	4.0	3.0	3.50	4	1	5	0	3	2	2.5	0	0
	Avg.	4.95	4.76	2.90	3.81	3.52	1.17	4.87	.07	2.95	2.27	2.60	.17	.20

TABLE NO. 6, LOT K2.

Showing the condition of the plants in the several boxes, March 22nd, 1905, 13 days after planting.

	No. of row.	Plants up.	IN INCHES.			Plants vigorous.	Plants weak.	Plants green.	Plants light colored.	Greatest number leaves.	Smallest number leaves.	Average number leaves.	Plants with diseased leaves.	Plants wilting.
			Height of tallest.	Height of smallest.	Average height.									
Box 5.	1	5	4.2	2.0	3.10	2	3	5	0	3	2	2.5	0	1
	2	4	4.6	2.6	3.60	2	2	4	0	3	2	2.5	0	0
	3	5	4.2	2.4	3.30	4	1	5	0	3	2	2.5	0	0
	4	5	4.4	4.2	4.30	5	0	5	0	3	2	2.5	0	0
	5	5	4.8	3.2	4.00	4	1	5	0	3	2	2.5	0	0
	6	5	5.3	4.0	4.65	5	1	5	0	3	3	3.0	0	0
	7	5	5.5	3.7	4.60	4	1	5	0	3	3	3.0	0	0
	8	5	4.1	2.5	3.30	4	1	5	0	3	2	2.5	0	0
	9	5	5.1	4.7	4.90	5	0	5	0	3	2	2.5	0	0
	10	5	5.0	2.1	3.55	4	1	4	1	3	2	2.5	0	0
Box 6.	11	4	5.2	4.3	9.75	4	0	4	0	3	2	2.5	0	0
	12	5	5.9	3.3	4.60	4	1	5	0	3	3	3.0	0	0
	13	5	6.0	4.5	5.25	5	0		1	3	3	3.0	0	0
	14	5	5.7	4.9	5.30	5	0	5	0	3	3	3.0	0	0
	15	5	6.0	5.1	5.55	4	1	5	0	3	2	2.5	0	0
	16	5	5.2	3.5	4.35	4	1	5	0	3	2	2.5	0	0
	17	5	5.0	3.6	4.30	4	1	5	0	3	2	2.5	0	0
	18	5	5.8	4.0	4.90	5	0	5	0	3	2	2.5	0	0
	19	5	6.1	4.3	5.10	5	0	5	0	3	3	3.0	0	0
	20	5	5.2	3.2	4.20	3	2	5	0	3	2	2.5	0	0
Box 7.	21	5	4.2	1.4	2.80	4	1	5	0	3	1	2.0	0	0
	22	5	4.2	2.0	2.10	4	1	5	0	3	2	2.5	0	0
	23	5	4.6	2.9	3.25	5	0	5	0	3	2	2.5	0	0
	24	4	4.8	3.2	4.00	2	2	4	0	3	2	2.5	0	0
	25	5	4.0	1.5	2.75	4	1	5	0	3	2	2.5	0	1
	26	5	5.3	3.1	4.20	5	0	5	0	3	2	2.5	0	0
	27	5	5.0	3.3	4.15	5	0	5	0	3	3	3.0	0	0
	28	5	4.7	2.9	3.80	4	1	5	0	3	2	2.5	0	0
	29	5	5.3	3.0	4.15	4	1	4	1	3	2	2.5	0	0
	30	5	5.2	1.2	3.20	4	1	4	1	3	1	2.0	0	1
Box 8.	31	5	5.0	4.2	4.65	5	0	5	0	3	3	3.0	0	0
	32	5	4.8	3.7	4.25	5	0	5	0	3	2	2.5	0	0
	33	5	4.9	3.3	4.10	5	0	5	0	3	3	3.0	0	0
	34	5	5.0	3.7	4.35	5	0	5	0	3	2	2.5	0	0
	35	5	6.2	3.8	5.00	5	0	5	0	3	2	2.5	0	0
	36	5	6.0	5.1	5.55	5	0	5	0	3	2	2.5	0	0
	37	5	4.6	3.7	4.15	5	0	5	0	3	2	2.5	0	0
	38	3	5.1	4.1	4.60	3	0	3	0	3	3	3.0	0	0
	39	5	5.0	3.9	4.45	5	0	5	0	3	3	3.0	0	0
	40	5	5.0	2.7	3.85	4	1	5	0	3	2	2.5	0	0
	Avg.	4.87	5.05	3.12	4.17	4.25	.62	4.77	.10	3.00	2.22	2.55	.00	.12

TABLE NO. 7, LOT N2.

Showing the condition of the plants in the several boxes, March 22nd, 1905, 13 days after planting.

			IN INCHES.											
	No. of row.	Plants up.	Height of tallest.	Height of smallest.	Average height.	Plants vigorous.	Plants weak.	Plants green.	Plants light colored.	Greatest number leaves.	Smallest number leaves.	Average number leaves.	Plants with diseased leaves.	Plants wilting.
Box 9.	1	5	3.7	2.5	3.10	2	3	5	0	3	3	3.0	0	4
	2	5	4.2	3.0	3.60	3	2	5	0	3	2	2.5	1	2
	3	5	4.6	3.1	3.85	3	2	5	0	3	2	2.5	0	1
	4	5	5.2	3.4	4.30	4	1	5	0	3	3	3.0	0	0
	5	5	4.2	4.0	4.10	3	2	5	0	3	2	2.5	0	0
	6	5	5.5	0.8	3.15	4	1	5	0	3	2	2.5	0	0
	7	4	4.3	2.1	3.20	3	1	4	0	3	2	2.5	0	0
	8	5	4.9	2.9	3.90	3	2	4	1	3	3	3.0	0	0
	9	5	5.0	3.5	4.25	5	0	5	0	3	3	3.0	0	0
	10	4	5.4	3.2	4.36	3	1	4	0	3	2	2.5	0	0
Box 10.	11	5	6.3	3.0	4.65	3	2	5	0	3	2	2.5	0	0
	12	4	6.0	4.3	4.45	4	0	4	0	3	3	3.0	0	0
	13	5	5.6	3.6	4.60	3	2	5	0	3	2	2.5	0	0
	14	5	4.5	3.7	4.10	4	1	5	0	3	2	2.5	0	0
	15	5	5.1	1.6	3.35	3	2	5	0	3	2	2.5	1	1
	16	5	5.5	4.0	4.75	4	1	5	0	3	3	3.0	0	0
	17	5	6.2	4.1	5.15	3	2	5	0	3	3	3.0	0	0
	18	5	4.5	3.1	3.80	2	3	5	0	3	2	2.5	0	0
	19	5	5.5	4.6	5.05	5	0	5	0	3	3	3.0	0	0
	20	5	5.0	3.5	4.25	2	3	3	2	3	2	2.5	0	0
Box 11.	21	5	5.2	3.5	4.35	5	0	5	0	3	2	2.5	1	2
	22	5	4.4	3.2	3.80	3	2	5	0	3	2	2.5	0	0
	23	5	4.6	0.7	2.65	3	2	4	1	3	2	2.5	0	0
	24	5	5.3	2.5	3.90	4	1	5	0	3	2	2.5	0	0
	25	5	4.3	3.5	3.90	5	0	4	1	3	2	2.5	0	0
	26	5	5.0	4.3	4.65	5	0	5	0	3	2	2.5	0	0
	27	5	4.3	3.3	3.80	4	1	5	0	3	2	2.5	0	0
	28	5	4.5	2.3	3.40	4	1	5	0	3	2	2.5	0	0
	29	4	3.4	2.8	3.10	1	3	4	0	2	2	2.5	0	0
	30	5	5.7	3.3	4.50	4	1	5	0	3	2	2.5	0	0
Box 12.	31	5	4.2	2.2	3.20	2	3	5	0	3	2	2.5	1	1
	32	5	4.5	2.9	3.70	3	2	5	0	3	2	2.5	0	0
	33	5	5.0	3.3	4.15	3	2	5	0	3	2	2.5	0	0
	34	4	5.0	3.9	4.45	3	1	4	0	3	2	2.5	0	0
	35	5	4.7	1.7	3.20	4	1	5	0	3	2	2.5	0	0
	36	5	4.9	3.7	4.80	5	0	5	0	3	3	2.0	0	0
	37	5	5.8	4.0	4.90	4	1	5	0	3	2	2.5	0	0
	38	5	4.6	2.1	3.35	4	1	5	0	3	2	2.5	0	0
	39	5	5.3	2.4	2.85	4	1	5	0	3	2	2.5	0	0
	40	5	5.3	1.7	4.00	4	1	5	0	3	2	2.5	0	0
	Avg.	4.85	4.95	3.03	3.98	3.50	1.37	4.75	.12	2.97	2.22	2.61	.10	.27

TABLE NO. 8, LOT R1.

Showing the condition of the plants in the several boxes, March 22nd, 1905, 13 days after planting.

			IN INCHES.											
	No. of row.	Plants up.	Height of tallest.	Height of smallest.	Average height.	Plants vigorous.	Plants weak.	Plants green.	Plants light colored.	Greatest number leaves.	Smallest number leaves.	Average number leaves.	Plants with diseased leaves.	Plants wilting.
Box 13.	1	5	4.8	3.3	4.05	5	0	4	1	3	2	2.5	0	0
	2	5	5.2	3.3	4.25	5	0	5	0	3	3	3.0	1	0
	3	5	4.3	3.3	3.80	5	0	5	0	3	2	2.5	0	0
	4	4	4.5	3.0	2.75	2	2	4	0	3	2	2.5	0	0
	5	4	4.0	3.5	3.75	4	0	4	0	3	2	2.5	0	0
	6	5	4.8	3.8	4.30	5	0	5	0	3	3	3.0	0	0
	7	5	4.7	4.0	4.35	5	0	5	0	3	3	3.0	0	0
	8	5	4.8	3.6	4.20	5	0	0	0	3	2	2.5	0	0
	9	5	5.2	4.2	4.70	5	0	5	0	3	2	2.5	0	1
	10	4	4.4	3.5	3.95	4	0	4	0	3	2	2.5	0	0
Box 14.	11	5	3.9	3.7	3.80	5	0	5	0	3	3	3.0	0	0
	12	5	5.3	3.4	4.35	4	1	5	0	3	2	2.5	0	0
	13	5	5.1	2.0	3.55	4	1	5	0	3	2	2.5	0	0
	14	4	4.8	1.9	3.35	2	2	4	0	3	2	2.5	0	1
	15	5	5.2	3.0	4.10	4	1	5	0	3	3	3.0	1	0
	16	5	4.6	2.0	3.30	3	2	5	0	3	2	2.5	0	1
	17	5	5.5	2.7	4.10	4	1	5	0	3	2	2.5	0	0
	18	5	4.5	3.2	3.85	4	1	5	0	3	2	2.5	0	0
	19	5	4.5	5.4	4.95	5	0	5	0	3	2	2.5	0	0
	20	5	4.6	4.1	4.35	5	0	5	0	3	3	3.0	0	2
Box 15.	21	5	4.9	3.4	4.15	5	0	5	0	3	2	2.5	0	0
	22	5	4.7	4.0	4.35	5	0	5	0	3	3	3.0	0	0
	23	5	5.5	4.1	4.80	5	0	5	0	3	3	3.0	0	0
	24	5	4.7	4.0	4.35	5	0	5	0	3	2	2.5	0	0
	25	5	5.3	1.5	3.40	4	1	5	0	3	2	2.5	0	1
	26	5	5.0	3.5	4.25	5	0	5	0	3	3	3.0	0	1
	27	5	5.1	3.6	4.35	5	0	5	0	3	3	3.0	0	0
	28	5	4.9	2.9	3.90	5	0	5	0	3	2	2.5	1	0
	29	5	5.5	4.4	4.95	5	0	5	0	3	3	3.0	0	0
	30	4	4.9	2.0	2.95	2	2	4	0	3	2	2.5	0	1
Box 16.	31	5	4.7	3.0	3.85	4	1	5	0	3	2	2.5	1	0
	32	5	4.4	0.8	2.60	4	1	5	0	3	1	2.0	0	0
	33	5	5.3	3.2	4.25	4	1	5	0	3	2	2.5	0	0
	34	5	5.7	4.4	5.05	5	0	5	0	3	3	3.0	0	0
	35	5	6.3	3.0	4.65	3	2	5	0	3	2	2.5	3	0
	36	5	4.4	3.6	4.00	3	2	5	0	3	3	3.0	0	0
	37	5	5.7	2.4	4.05	3	2	5	0	3	2	2.5	0	1
	38	5	4.0	2.5	3.25	3	2	5	0	3	2	2.5	0	0
	39	5	5.3	2.9	4.10	3	2	5	0	3	2	2.5	1	0
	40	5	4.7	3.7	4.20	4	1	5	0	3	2	2.5	0	2
	Avg.	4.85	4.89	3.24	4.06	4.17	.70	4.85	.02	3.00	2.30	2.65	.20	.27

TABLE NO. 9, LOT M2.

Showing the condition of the plants in the several boxes, March 26th, 1905, four days after water had been withheld.

In this set of notes dated March 26th, in the column headed "Condition from Drought," G means good, VG means very good, B means bad and VB means very bad.

	No. of ear.	No. of plants.	IN INCHES.			Plants vigorous.	Plants weak.	Plants green.	Plants light colored.	Greatest number leaves.	Smallest number leaves.	Average leaves.	Plants with diseased leaves.	Plants wilting.	Cond. from drought.
			Height of Tallest.	Height of smallest.	Average Height.										
Box 1.	1	5	7.1	5.1	6.10	3	2	5	0	3	3	3.0	1	5	B
	2	5	7.2	5.5	6.35	4	1	5	0	3	3	3.0	1	5	B
	3	5	6.7	4.8	5.75	4	1	5	0	3	3	3.0	1	5	B
	4	55	6.7	4.5	5.60	4	1	5	0	3	2	2.5	2	5	B
	5	5	8.6	5.0	6.80	3	2	5	0	3	3	3.0	0	5	B
	6	5	6.8	4.6	5.70	2	3	5	0	3	3	3.0	1	5	B
	7	5	8.4	5.0	6.70	3	2	5	0	3	2	2.5	0	5	B
	8	5	7.0	2.0	4.50	2	3	5	0	3	2	2.5	0	5	B
	9	5	6.8	5.0	5.90	3	2	5	0	3	3	3.0	1	5	B
	10	5	6.4	3.8	5.10	3	2	5	0	3	3	3.0	1	5	B
Box 2.	11	5	9.5	4.8	7.15	4	1	5	0	3	3	3.0	0	0	VG
	12	4	9.5	3.1	6.30	3	1	4	0	3	3	3.0	0	0	VG
	13	5	7.8	5.2	6.50	3	2	5	0	3	2	3.0	0	0	VG
	14	5	8.1	6.7	7.40	5	0	5	0	3	3	3.0	0	0	VG
	15	5	7.4	4.0	5.70	3	2	5	0	3	3	3.0	0	0	VG
	16	5	7.7	6.5	7.10	5	0	5	0	3	3	3.0	0	0	VG
	17	5	7.4	6.3	6.85	5	0	5	0	3	3	3.0	0	0	VG
	18	5	6.3	5.6	5.95	5	0	5	0	3	3	3.0	0	0	VG
	19	5	7.8	5.8	6.80	5	0	5	0	3	3	3.0	0	0	VG
	20	5	8.6	4.4	6.50	4	1	5	0	3	3	3.0	0	0	VG
Box 3.	21	5	5.9	3.2	4.55	2	3	5	0	3	3	3.0	3	5	VB
	22	5	3.4	3.0	4.20	1	4	5	0	3	3	3.0	3	5	VB
	23	5	4.9	4.2	4.55	2	3	5	0	3	3	3.0	1	5	VB
	24	5	5.9	3.0	4.45	0	5	5	0	3	2	2.5	4	5	VB
	25	5	3.8	1.8	2.80	0	5	5	0	3	2	2.5	3	5	VB
	26	5	4.8	3.5	4.15	0	5	5	0	3	2	2.5	3	5	VB
	27	5	5.4	4.8	5.10	0	5	5	0	3	2	2.5	1	5	VB
	28	5	5.7	3.7	4.70	0	5	5	0	3	2	2.5	3	5	VB
	29	5	4.5	2.0	3.25	0	5	5	0	3	2	2.5	1	5	VB
	30	5	4.3	3.5	3.90	0	5	5	0	3	2	2.5	2	5	VB
Box 4.	31	5	6.3	2.4	4.35	3	2	5	0	3	3	3.0	0	5	B
	32	5	5.9	4.7	5.30	3	2	5	0	3	3	3.0	1	3	B
	33	5	5.7	5.5	5.60	4	1	5	0	3	3	3.0	0	5	B
	34	5	6.4	5.0	5.20	5	0	5	0	3	3	3.0	0	4	B
	35	4	6.3	3.5	4.90	3	1	4	0	3	3	3.0	0	4	B
	36	5	6.0	4.0	5.00	3	2	5	0	3	3	3.0	0	4	B
	37	5	5.6	2.2	3.90	4	1	5	0	3	3	3.0	0	2	B
	38	5	6.4	4.3	5.35	4	1	5	0	3	3	3.0	0	2	G
	39	5	7.3	4.8	6.05	5	0	5	0	3	3	3.0	0	0	VG
	40	5	6.0	5.3	5.15	5	0	5	0	3	3	3.0	0	0	VG
	Avg.	4.95	6.60	4.40	5.43	2.92	2.02	4.95	0.00	3.00	2.75	2.87	.82	3.25	

TABLE NO. 10, LOT K2.

Showing the condition of the plants in the several boxes, March 26th, 1905, four days after water had not been withheld.

			IN INCHES.												
	Number of ear.	Number of Plants.	Height of Tallest.	Height of Smallest.	Average Height.	Plants Vigorous.	Plants weak.	Plants green.	Plants light colored.	Greatest number leaves.	Smallest number leaves.	Average leaves.	Plants with diseased leaves.	Plants wilting.	Cond. from drought.
Box 5.	1	5	6.0	1.9	3.95	3	2	5	0	3	2	2.5	1	0	G
	2	4	6.4	3.7	5.05	2	2	4	0	3	3	3.0	0	0	G
	3	5	6.0	3.2	4.60	4	1	5	0	3	2	2.5	1	0	VG
	4	5	5.8	5.0	5.40	5	0	5	0	3	3	3.0	0	0	VB
	5	5	5.7	4.2	4.95	4	1	5	0	3	2	2.5	0	0	VG
	6	5	7.3	6.6	6.95	5	0	5	0	3	3	3.0	0	0	VG
	7	5	6.9	5.0	5.95	5	0	5	0	3	3	3.0	0	0	VG
	8	5	5.9	3.9	4.90	3	2	5	0	3	2	2.5	0	5	B
	9	5	6.2	4.8	5.50	5	0	5	0	3	2	2.5	0	4	G
	10	5	6.0	3.5	4.75	4	1	5	0	3	2	2.5	2	3	B
Box 6.	11	4	6.0	4.5	5.25	4	0	4	0	3	3	3.0	0	4	G
	12	5	7.6	4.2	5.90	4	1	5	0	3	3	3.0	0	1	VG
	13	5	7.2	5.4	6.30	5	0	4	1	3	3	3.0	0	2	VG
	14	5	6.3	6.1	6.20	5	0	5	0	3	3	3.0	0	1	VG
	15	5	8.0	1.0	4.50	4	1	5	0	3	1	2.0	0	1	VG
	16	5	7.4	4.7	6.05	4	1	5	0	3	2	2.5	0	1	VG
	17	5	6.6	5.3	5.95	4	1	5	0	3	2	2.5	0	3	VG
	18	5	6.9	5.7	6.30	5	0	5	0	3	3	3.0	0	4	VG
	19	5	8.4	6.0	7.20	5	0	5	0	3	3	3.0	0	4	G
	20	5	6.8	3.7	5.25	3	2	5	0	3	2	2.5	0	3	B
Box 7.	21	5	4.1	1.3	2.70	0	5	5	0	3	2	2.5	0	5	VB
	22	5	4.2	2.0	3.10	0	5	5	2	3	2	2.5	0	5	VB
	23	5	3.5	3.0	3.25	0	5	5	0	3	2	7.5	0	5	VB
	24	4	3.8	3.4	3.60	0	4	4	0	3	2	2.5	0	4	VB
	25	5	4.0	1.4	2.70	0	5	5	0	2	2	2.5	3	5	VB
	26	5	4.7	2.8	3.75	0	5	5	0	2	2	2.5	1	5	VB
	27	5	5.0	3.4	4.20	0	5	5	0	3	2	2.5	1	5	VB
	28	5	4.6	3.0	3.80	0	5	5	0	2	2	2.5	0	5	VB
	29	5	5.4	3.0	4.20	0	5	5	0	3	2	2.5	4	5	VB
	30	5	5.2	1.0	3.10	0	5	5	0	3	2	2.5	3	5	VB
Box 8.	31	5	5.0	5.0	5.00	0	5	5	0	3	3	2.5	1	5	VB
	32	5	4.8	4.0	4.40	1	4	5	0	3	2	2.5	0	5	VB
	33	5	5.1	3.5	4.30	1	4	5	0	3	2	2.5	1	5	VB
	34	5	5.3	3.9	4.65	0	5	5	0	3	2	2.5	0	5	VB
	35	5	5.7	3.5	4.60	0	5	5	0	3	2	2.5	1	5	VB
	36	5	5.9	5.4	3.65	0	5	5	2	3	2	5.5	1	5	VB
	37	5	4.4	3.6	4.00	0	5	5	0	3	2	2.5	1	5	VB
	38	3	5.1	4.4	4.75	0	3	3	0	3	3	3.0	0	3	VB
	39	5	5.0	4.2	4.60	0	5	5	0	3	2	2.5	3	5	VB
	40	5	5.0	3.2	4.10	0	5	5	0	3	2	2.5	1	5	VB
	Avg.	4.87	5.73	3.83	4.73	2.12	2.75	4 97	.02	2.92	2.27	2.68	.60	3.32	

TABLE NO. 11, LOT N2.

Showing the condition of the plants in the several boxes, March 26th, 1905, four days after water had been withheld.

			IN INCHES.													
	Number of ear.	Number of Plants.	Height of Tallest.	Height of Smallest.	Average Height.	Plants Vigorous.	Plants weak.	Plants green.	Plants light colored.	Greatest number leaves.	Smallest number leaves.	Average leaves.	Plants with diseased leaves.	Plants wilting.	Cond. from drought.
Box 9.	1	5	3.8	2.4	3.10	2	3	5	0	3	2	2.5	0	5	VB
	2	5	4.0	2.8	3.40	2	3	5	0	3	2	2.5	1	5	VB
	3	5	4.1	3.0	3.55	3	2	5	0	3	2	2.5	2	5	VB
	4	5	4.6	3.0	3.80	2	3	5	0	3	2	2.5	1	5	VB
	5	5	4.4	4.0	4.20	4	1	5	0	3	2	2.5	2	5	VB
	6	5	5.5	0.7	3.10	4	1	4	1	3	1	2.0	3	5	VB
	7	4	4.3	2.0	3.15	0	4	3	1	3	2	2.5	2	4	VB
	8	5	4.8	2.7	3.75	3	2	5	0	3	2	2.5	2	5	VB
	9	5	4.7	3.4	4.05	3	2	5	0	3	3	3.0	5	5	VB
	10	4	5.7	3.2	4.45	1	3	4	0	3	2	2.5	2	4	VB
Box 10.	11	5	6.9	4.2	5.55	3	2	5	0	3	2	2.5	0	0	G
	12	4	6.9	5.5	6.20	4	0	4	0	3	3	3.0	0	1	G
	13	5	6.4	4.4	5.40	2	3	5	0	3	3	3.0	0	5	B
	14	5	6.1	4.7	5.40	4	1	5	0	3	2	2.5	0	5	B
	15	5	6.6	2.3	4.45	3	2	5	0	3	2	2.5	0	4	B
	16	5	7.3	5.3	6.30	5	0	5	0	3	3	3.0	1	5	G
	17	5	6.8	5.8	6.30	5	0	5	0	3	3	3.0	0	5	G
	18	5	5.7	4.3	5.00	2	3	5	0	3	2	2.5	1	5	B
	19	5	6.5	5.6	6.05	3	2	5	0	3	3	3.0	1	5	B
	20	5	5.6	4.6	5.10	3	2	5	0	3	3	3.0	2	5	B
Box 11.	21	5	6.1	3.7	4.90	2	3	5	0	3	2	2.5	0	5	B
	22	5	5.0	3.9	4.45	2	3	5	0	3	3	3.0	0	5	B
	23	4	5.8	3.0	4.40	3	1	4	0	3	3	3.0	0	4	B
	24	5	6.7	5.0	4.85	4	1	5	0	3	2	2.5	0	5	G
	25	5	4.4	4.2	4.30	0	5	5	0	3	3	3.0	2	5	B
	26	5	5.6	4.9	5.25	5	0	5	0	3	2	2.5	0	4	G
	27	5	4.6	3.5	4.05	0	5	5	0	3	2	2.5	1	5	VB
	28	5	5.0	2.8	3.90	4	1	5	0	3	2	2.5	1	5	VB
	29	4	3.8	3.3	3.55	0	4	4	0	2	2	2.5	1	4	VB
	30	5	6.2	3.5	4.85	3	2	5	0	3	2	2.5	1	5	B
Box 12.	31	5	6.5	4.0	5.25	3	2	5	0	3	3	3.0	1	0	VG
	32	5	6.2	4.5	5.35	3	2	5	0	3	3	3.0	1	0	VG
	33	5	6.4	4.4	5.35	4	1	5	0	3	3	3.0	0	0	VG
	34	4	5.8	5.0	5.40	3	1	4	0	3	3	3.0	0	0	VG
	35	5	7.1	3.2	5.15	4	1	5	0	3	2	2.5	0	0	VG
	36	5	6.2	5.5	5.85	4	1	5	0	3	3	3.0	0	0	VG
	37	5	7.8	5.1	6.40	4	1	5	0	3	3	3.0	0	0	VG
	38	5	6.4	3.5	4.95	3	2	5	0	3	2	2.5	0	0	G
	39	5	8.3	3.8	6.05	4	1	5	0	3	3	3.0	0	0	G
	40	5	8.8	3.3	6.05	4	1	5	0	3	3	3.0	0	0	VG
	Avg.	4.85	5.83	3.79	4.81	2.92	1.92	4.80	.05	2.97	2.42	2.71	.80	3.37	

TABLE NO. 12, LOT R1.

Showing the condition of the plants in the several boxes, March 26th, 1905, four days after water had been withheld.

	Number of ear.	Plants up.	IN INCHES.			Plants Vigorous.	Plants weak.	Plants green.	Plants light colored.	Greatest number leaves.	Smallest number leaves.	Average leaves.	Plants with diseased leaves.	Plants wilting.	Cond. from drought.
			Height of Tallest.	Height of Smallest.	Average Height.										
Box 13.	1	5	6.4	4.8	5.60	4	1	4	1	3	3	3.0	0	0	VG
	2	5	7.2	5.2	6.20	5	0	5	0	3	3	3.0	1	0	VG
	3	5	6.4	5.0	5.70	3	2	5	0	3	3	3.0	0	0	VG
	4	4	6.3	3.9	5.10	2	2	4	0	3	3	3.0	0	0	G
	5	4	5.5	4.9	5.20	4	0	4	0	3	3	3.0	0	0	G
	6	5	6.2	5.7	4.95	5	0	5	0	4	3	3.5	0	0	VG
	7	5	7.0	6.0	6.50	5	0	5	0	4	3	3.5	0	0	VG
	8	5	7.0	5.8	6.40	3	3	5	0	4	3	3.5	0	0	VG
	9	5	7.3	5.6	6.45	5	0	5	0	3	3	3.0	0	0	VG
	10	4	7.0	6.0	6.50	4	0	4	0	3	3	3.0	0	0	G
Box 14.	11	5	5.5	5.0	5.25	5	0	5	0	3	3	3.0	0	0	G
	12	5	7.1	5.1	6.10	4	1	5	0	3	3	3.0	0	0	VG
	13	5	6.8	3.7	5.25	2	3	5	0	4	3	3.5	0	0	G
	14	4	6.5	4.0	5.25	2	2	4	0	3	3	3.0	1	0	G
	15	5	7.3	4.3	5.80	4	1	5	0	4	3	3.5	1	0	VG
	16	5	5.8	3.2	4.50	3	2	5	0	3	2	2.5	0	0	G
	17	5	8.0	4.4	6.20	4	1	5	0	4	3	3.5	0	0	VG
	18	5	5.5	4.2	4.85	5	0	5	0	3	3	3.0	0	0	VG
	19	5	7.4	5.0	6.20	4	1	5	0	3	3	3.0	0	0	VG
	20	5	7.0	5.4	6.20	5	0	5	0	4	3	3.5	0	0	VG
Box 15.	21	5	7.3	5.3	6.15	5	0	5	0	4	3	3.5	0	0	VG
	22	5	6.6	5.5	5.75	5	0	5	0	3	3	3.0	0	0	VG
	23	5	7.2	6.1	6.65	5	0	5	0	4	3	3.5	0	0	VG
	24	5	6.4	5.2	5.80	5	0	5	0	3	3	3.0	0	0	VG
	25	5	6.5	3.3	4.90	4	1	5	0	3	3	3.0	0	0	VG
	26	5	7.0	4.5	5.75	4	1	5	0	3	3	3.0	0	0	VG
	27	5	7.2	5.5	6.35	5	0	5	0	3	3	3.0	0	0	VG
	28	5	7.3	4.8	6.05	3	2	5	0	3	3	3.0	0	0	G
	29	5	7.5	6.3	6.90	5	0	5	0	3	3	3.0	0	0	VG
	30	4	6.5	2.8	4.65	3	1	4	0	3	3	3.0	1	0	G
Box 16.	31	5	4.6	3.0	3.80	0	5	5	0	3	2	2.5	1	5	VB
	32	4	4.6	4.2	4.40	1	3	4	0	3	2	2.5	1	4	VB
	33	5	5.5	3.3	4.40	0	5	5	0	3	2	2.5	1	5	VB
	34	5	5.6	4.6	5.10	3	2	5	0	3	3	3.0	3	5	VB
	35	5	6.4	2.8	4.60	3	2	5	0	3	2	2.5	3	2	VB
	36	5	4.2	3.6	3.90	0	5	5	0	3	2	2.5	1	5	VB
	37	5	5.8	2.2	4.00	0	5	5	0	3	2	2.5	1	5	VB
	38	5	3.8	3.0	3.40	0	5	5	0	3	2	2.5	1	5	VB
	39	5	4.5	3.7	3.60	0	5	5	0	3	2	2.5	0	0	VB
	40	5	4.0	3.5	3.75	0	5	5	0	3	2	2.5	2	5	VB
	Avg.	4.85	6.26	4.48	5.35	3.20	1.65	4.82	.02	3.22	2.77	2.91	.45	1.22	

TABLE NO. 13, LOT M2.

Showing condition of plants April 3rd, 1905, seven days after water had been applied after drought.

1.	Green and growing. Lower leaves dying.	21.	All the plants green, but badly withered. Commencing to die at tips of lower leaves.
2.		22.	
3.		23.	
4.		24.	
5.		25.	
6.		26.	
7.		27.	
8.		28.	Green and growing.
9.		29.	
10.		30.	
11.		31.	
12.		32.	Lower leaves dying.
13.		33.	
14.		34.	
15.		35.	
16.		36.	
17.		37.	
18.		38.	
19.		39.	
20.		40.	

There are fewer dead plants here than in any other lot.

TABLE NO. 14, LOT K2.

Showing condition of plants April 3rd, 1905, seven days after water had been applied after drought.

1.	4.	Green	21.	4 green.
2.	3.		22.	5 green, plants commencing to die.
3.	5.		23.	1 dead, 4 dying.
4.	5.		24.	Dying.
			25.	
6.	5.		26.	
7.	5.		27.	
8.	5.		28.	
9.	5.		29.	
10.	5.		30.	
11.		All green except one plant 13, which is white.	31.	Plants green but commencing to die at tips of leaves.
12.			32.	
13.			33.	
14.			34.	
15.			35.	
16.			36.	Badly withered and mostly dead, except on plant in 38.
17.			37.	
18.			38.	
19.			39.	
20.			40.	

TABLE NO. 15, LOT N2.

Showing condition of plants April 3rd, 1905, seven days after water had been applied after drought.

1.	Dead.	21.	Green and growing, but lower leaves withered.
2.		22.	
3.		23.	
4.		24.	
5.	Green and badly withered.	25.	
6.		26.	
7.		27.	green and growing, but lower leaves. dying.
8.		28.	
9.		29.	
10.		30.	
11.	Green and growing, but lower leaves withered.	31.	
12.		32.	
13.		33.	
14.		34.	
15.		35.	
16.		36.	
17.		37.	
18.		38.	
19.		39.	
20.		40.	

TABLE NO. 16, LOT R1.

Showing condition of plants April 3rd, 1905, seven days after water had been applied after drought.

1.	Plants green and healthy, but the lower leaves have commenced to turn brown, owing to lack of plant food.	21.	Plants green and healthy, but the lower leaves have commenced to turn brown, owing to lack of plant food.
2.		22.	
3.		23.	
4.		24.	
5.		25.	
6.		26.	
7.		27.	
8.		28.	
9.		29.	
10.		30.	
11.		31.	Green but small, commencing to die.
12.		32.	
13.		33.	
14.		34.	
15.		35.	
16.		36.	Plants dead or badly withered, except two in 37. These plants were near steam pipes, where the heat was slightly greater.
17.		37.	
18.		38.	
19.		39.	
20.		40.	

Below will be found the four lots in alphabetical order from left to right, and in a column at the left of the page will be found the several points for consideration, and under each lot number will be placed the averages, as deduced from the foregoing notes. The first column under each is for the first set of notes taken March 21st and 22nd, the second column for the second set, taken March 26th, after five days drought.

In the notes on the condition of the plants from drought, G means good, V. G, very good, B. bad and V. B. very bad.

Lot	K2		M2		N2		R1	
Avg. weight per grain	.3961 grms.		.3866 grms.		.3741 grms.		.3573 grms.	
Average No of plants up	4.87	4.87	4.95	4.95	4.85	4.85	4.85	4.85
Average height in inches	4.17	4.73	3.81	5.43	3.98	4.81	4.81	5.35
Average No. plants vigorous	4.25	2.12	3.52	2.92	3.50	2.92	4.17	3.20
Average No of leaves	2.55	2.68	2.60	2.87	2.61	2.65	2.65	2.91
Average Condition from Drought.	12 .. G.		12 V. G.		8 V. G.		21 V. G	
	20 V. B.		8 V. B.		13 V. B.		10 V. B.	

CONCLUSIONS FROM THE FOREGOING DATA.

In germinating qualities, M2 the second heaviest grain, stands first. In height of plant, K2 took the lead in the first notes, but after the plants had been deprived of moisture, M2 came first. In regard to vigor, K2 was ahead at first, but the drought diminished the vigor of the plants. At the taking of the second set of notes, R1 had the greatest amount of vigor. This is, of course, an important point to consider, and one point that is in favor of R1 in this respect, is that it is more highly bred than any of the other varieties, having been carefully bred and selected by Funk Bros., of Bloomington, Ill., for six years prior to 1904, when the seed for the breeding plot here was procured from them. The last notes taken, April 3rd, show that there are fewer dead plants in M2 than in any other lot.

These facts indicate:

1st. That the heaviest grains do not necessarily have the best germinating qualities.

2nd. That they do attain the greatest height when supplied with moisture, but this need not hold true in time of drought.

3rd. That they may have more vigor when moisture is abundant, but when the supply of moisture is cut off, the plants from the highest bred seed hold their vigor better than any of the others.

4th. That the plants from the heaviest grains do not revive most quickly after moisture has been supplied again after drought.

EXPERIMENT NO. 2.

To determine the relation between the size of the germ in the corn kernel and the vigor of the resulting plant.

The grains were divided into three classes, according to the size of their germ, viz., large, medium and small. It was endeavored to procure kernels of as near the same size as possible in all three divisions, the variation being only in the size of the germ. All kernels used in this experiment were from the same variety of corn, Munikhuysen. There were 25 kernels in each class, making a total of 75 kernels in the test. The grains were taken, five from each ear, as follows:

LARGE GERM.

M2, 9	M2, 20	M2, 23	M2, 29	M2, 37
1, 2, 3, 4, 5	6, 7, 8, 9, 10	11, 12, 13, 14, 15	16, 17, 18, 19, 20	21, 22, 23, 24, 25

MEDIUM GERM.

M2, 31	M2, 33	M2, 36	M2, 38	M2, 39
1, 2, 3, 4, 5	6, 7, 8, 9, 10	11, 12, 13, 14, 15	16, 17, 18, 19, 20	21, 22, 23, 24, 25

SMALL GERM.

These ears were taken from the following numbered rows in breeding lot M1:

8	33	34	34	40
1, 2, 3, 4, 5	6, 7, 8, 9, 10	11, 12, 13, 14, 15	16, 17, 18, 19, 20	21, 22, 23, 24, 25

Five other kernels from the same ears were selected as representing the germs in each class, and after being soaked in water until they became slightly softened, the germs were removed and dried and the weights of the germs taken, and found to be as follows:

	Total weight of germ.	Average weight of germ.
Large Germs	.2849 grms.	.05698 grms.
Medium Germs	.1665 grms.	.03330 grms.
Small Germs	.1417 grms.	.02834 grms.

All the kernels from each of the three divisions were planted in one box, so as to give uniform condition. The size of the box was 52 inches by eight inches, inside dimensions, allowing the kernels to be planted two inches apart each way. The depth of box was 2 1-4 inches, and the depth of sand in the box 2 inches. These kernels were planted and the box placed in the greenhouse on March 10th, 1905, and the kernels commenced to come up on Friday, March 17th, or seven days after planting. All of the kernels in each of the three divisions sprouted, giving 25 plants in each. Notes were taken March 22nd, 12 days after planting, March 26th, April 3rd and April 14th. Water was applied regularly up to April 3rd, after which date no water was applied.

TABLE NO. 17.

Showing condition of plants from large germ kernels at different stages of growth.

No. of plant.	March 22nd, 12 days after planting. Height of plant in inches.	March 22nd, 12 days after planting. Number of leaves.	March 26th, 16 days after planting. Height of plant in inches.	March 26th, 16 days after planting. Number of c leaves.	April 3d, 22 days after planting. Height of plant in inches.	April 3d, 22 days after planting. xNumber of leaves.
1	3.8*	3†	5.7*	3†	9.0*	4†
2	3.9‡	3†	3.9*	3†	9.0*	4†
3	3.9*	3†	3.9*	3†	8.7*	4†
4	3.9*	3†	5.9*	3†	8.9*	4†
5	4.0*	3†	6.3*	3†	9.4*	4†
6	2.9*	3†	4.6*	3†	7.5*	4†
7	2.8‡	2†	5.3*	3†	8.0*	4†
8	4.3*	2†	7.3*	3†	10.9*	4†
9	2.6‡	2†	4.5*	3†	6.7*	4†
10	3.3*	3†	5.3*	3†	8.0*	4†
11	3.8*	3b	6.0*	3†	10.0*	4†
12	3.8*	2†	7.0*	3†	9.6*	4†
13	3.3*	2†	5.8*	3†	9.4*	4†
14	2.7‡	2†	5.4*	3†	9.9*	4†
15	3.4*	2†	6.7*	3†	9.6*	4†
16	3.8*	3†	6.5*	3†	10.2*	4†
17	2.4‡	2†	4.2*	3†	6.3*	4†
18	3.2*	3†	5.3*	3†	8.6*	4†
19	3.3*		5.9*	3†	8.7*	4†
20	3.2*	3†	4.5*	3†	10.6*	4†
21	2.6*	2a	4.4*	3†	7.7*	4†
22	2.9*	2†	4.7*	3†	7.7*	4†
23	2.9*	2†	4.8*	3†	7.8*	4†
24	3.5*	3†	5.4*	3†	9.0*	4†
25	2.7‡	3†	4.6*	3†	8.5*	4†
Avg....	3.31	2.56	5.36	3	8.78	4

* Vigorous. † Green. ‡ Weak. x Diseased leaves. a Light colored. b Wilting.

xThe lowest leaf is dying on all plants except No's 3, 12 and 23.

TABLE NO. 18.

Showing condition of plants from medium germ kernels at different stages of growth.

No. of plant.	March 22nd, 12 days after planting.		March 26th, 16 days after planting.		April 3d, 22 days after planting.	
	Height of plant in inches.	Number of leaves.	Height of plant in inches.	Number of leaves.	Height of plant in inches.	cNumber of leaves.
1	2.8*	2†	4.7*	3†	7.8*	4†
2	3.4*	3†	5.5*	3†	8.2*	4
3	3.6*	2†	6.3*	3†	8.9*	4†
4	3.5*	2†	5.9*	3†	9.5*	4†
5	3.7*	2†	6.4*	3†	9.8*	4†
6	2.6‡	2†	4.5*	3†	7.5‡	4†
7	2.5‡	2†	4.1*	3†	6.0*	4†
8	3.4*	2†	5.0*	3†	7.2‡	4†
9	2.8‡	2†	5.2*	3†	7.4*	4†
10	2.8‡	2†	5.1*	3†	7.4‡	4†
11	3.1*	2†	5.6*	3†	8.5*	4†
12	4.1*	2†	6.5*	3†	10.2*	4†
13	3.3*	2†	5.0*	3†	9.6*	4†
14	3.6*	2†	7.1*	3†	8.4*	4†
15	3.6*	3†	6.1*	3†	8.9*	4†
16	3.0*	3†	6.1*	3†	8.8*	4†
17	3.0*	3†	5.0*	3†	8.3*	4†
18	3.6*	2†	5.7*	3†	8.6*	4†
19	4.2*	2†	7.3*	3†	8.7*	4†
20	3.8*	3†	6.8*	3†	10.9*	4†
21	3.3*	2†	5.2*	3†	7.6*	4†
22	3.9*	2†	6.0*	3†	10.5*	4†
23	3.8x	2b	6.7*	3†	10.2*	4†
24	3.5*	3†	5.6*	3†	8.1*	4†
25	4.7*	3†	6.8*	4†	9.8*	4†
Avg....	3.42	2.28	5.76	3.4	8.67	4

* Vigorous. † Green. ‡ Weak. x Diseased leaves. a Light colored. b Wilting.

c Lowest leaf on each plant dead.

TABLE NO. 19.

Showing condition of plants from small germ kernels at different stages of growth.

	March 22nd, 12 days after planting.		March 26th, 16 days after planting.		April 3d, 22 days after planting.	
No. of plant.	Height of plant in inches.	Number of leaves.	Height of plant in inches.	Number of leaves.	Height of plant in inches.	cNumber of leaves.
1	2.7‡	2†	4.5*	3†	7.3‡	4a
2	3.0‡	2†	5.1‡	3†	7.9*	4†
3	2.5‡	2†	4.3‡	3a	5.8‡	3a
4	3.0‡	2a	4.4‡	4a	6.6‡	4a
5	3.0‡	3†	4.0‡	3a	6.0‡	4a
6	2.6‡	2†	3.5*	3†	5.1‡	3†
7	2.2‡	2†	3.1‡	3†	4.7‡	3†
8	2.8‡	2†	4.2*	3†	5.6‡	3†
9	2.4‡	2†	3.8‡	3†	5.0‡	4†
10	2.4‡	2†	3.7‡	3†	5.1*	3†
11	3.5*	3†	5.3*	3†	8.3*	4†
12	3.7*	3†	5.4*	3†	8.0*	4†
13	3.9*	3†	5.8‡	3†	8.4*	4†
14	4.0*	3†	6.0*	3†	8.5*	4†
15	3.9*	2†	5.2*	3†	7.5*	4†
16	4.0*	3†	6.2*	3†	9.0*	4†
17	2.8*	2†	4.7*	3†	7.0*	4†
18	3.3*	3†	5.6*	3†	8.2*	4†
19	3.5*	2†	6.3*	3†	9.2*	4†
20	3.8*	3†	5.5*	3†	9.5‡	4†
21	3.3*	3†	4.7*	3†	7.1†	4†
22	3.0*	2a	4.0*	3†	5.9‡	4†
23	2.9‡	2†	4.2*	3†	6.5*	3†
24	3.5*	2†	5.2*	3†	8.5*	4†
25	3.1*	3†	4.8*	3†	7.3*	4†
Avg....	3.15	2.4	4.78	3	7.12	3.76

* Vigorous. † Green. ‡ Weak. x Diseased leaves. a Light colored. b Wilting.

c Lowest leaf dead on all except No.'s 2, 3, 4, 7 and 8.

Condition of plants April 14th, 11 days after water was withheld.

Plants from large germ. No. 25 is still all green. In all the others, the lower leaves are dead, the upper one and sometimes two leaves are still green.

Plants from medium germ. Plants more seriously injured than with the large germ, but none dead. All the lower leaves are dead, but the top leaf still grows at top of plant.

Plants from small germ. Most plants entirely dead, a few, however, showing some green in a portion of the top leaf.

The plants from large germs have grown several inches since last notes were taken, those from the medium, not quite so much, and those from the small germs scarcely any.

There is a gradual falling off in size from large germ plants to small germ plants.

CONCLUSIONS FROM FOREGOING DATA.

Below will be found the three classes arranged from left to right, and in a column at the left of the page will be found the several points for consideration, and under each class will be placed the average as deduced from the foregoing notes. The three columns under each class numbered 1, 2 and 3, refer to the first, second and third sets of notes respectively.

	Large Germs.			Medium Germs.			Small Germs.		
	1	2	3	1	2	3	1	2	3
Germinating quality	All up	All up	All up	All up	All up	All up	All up	All up	All up
Average height of plant	3.31	5.52	8.78	3.42	5.76	8.67	3.15	4.78	7.12
Vigorous plants	18	25	25	21	25	22	14	17	14
Average number of leaves	2.56	3.00	4.00	2.32	3.04	4.00	2.40	3.00	3.76
Plants wilting	1	0	0	1	0	0	0	0	0
Lowest leaf dead	......	......	2.2	......	......	2.5	......	......	2.0

In the above scheme it will be noticed that all the plants came up in each class, making the germinating property equal. In regard to the height of plant, the medium germs lead in the first and second set of notes, the large germs coming second, and the small germs third. In the third set, the large germs are first, the medium second and the small third.

Of vigorous plants there were more at first in the medium germs, but as the plants increased in age, the number of vigorous plants was found to be greater from the large germ kernels.

The third set of notes taken April 14th, after the plants had been deprived of water since April 3rd, show a greater number of dead leaves in the plants coming from the *large* and *medium* classes than in those coming from the small. This is probably because the plants being more hardy and vigorous, have exhausted the supply of nourishment and commenced to die from lack of it. From the foregoing facts we may draw the following conclusions, viz: 1st. The germinating property of kernels having different sizes of germs may be equal.

2nd. The kernels having smaller germs may produce plants of a greater height while young, but the plants from the kernels having the larger germs will take the lead as the plants grow older.

3rd. The plants from kernels having large germs are more vigorous, have more plant energy and are stronger and hardier in every way.

4th. The plants from large germ kernels withstand drought better, and while at the beginning there may be some wilting plants, by virtue of their high degree of growing force, they are able to overcome this to the greatest extent in the large, next in the medium and last in the small germs.

The number of leaves does not vary much, but at the conclusion of the experiment, the number of leaves was the same in the large and medium germs, and less in the small. There is one wilting plant in the large and one in the medium classes in the first notes. After that the plants revived and no more wilting plants were noted. At the time of the third observation there were 25 plants having the lowest leaf dead in the medium, 22 in the large and 20 in the small.

SUMMARY.

As a result of these experiments the following conclusions are drawn, viz:

1. Erperiments to determine if the size of the kernels as determined by the weight, have any effect on the vigor of the plant show:

(a.) The heaviest grains do not necessarily have the best germinating qualities.

(b.) Plants from the heaviest grains attain the greatest height when supplied with moisture, but this need not hold true in time of drought.

(c.) Plants from the highest bred seed hold their vigor better than others during drought.

(d.) The heaviest grains do not necessarily revive most quickly after moisture has been supplied succeeding a drought.

2. Experiment to determine the relation between the size of the germ and the vigor of the resulting plant show:

(a.) The germinating properties of the kernels containing different sizes of germs may be equal.

(b.) As the plants grow older the largest, hardiest and most vigorous plants come from the kernels with the large germs.

(c.) The plants from the kernels with the largest germs withstand the drought best.

CONCLUSIONS.

These experiments indicate that in the selection of seed corn, the following points should be observed:

1. That there is not only a great difference in the individuality of plants coming from kernels from different ears, but from kernels of the same ear.

2. High breeding is of more importance than weight or size of grain, and

3. To insure a good stand and a large yield, none but large germed kernels should be used.

THE MARYLAND
AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 107. OCTOBER, 1905.

1905-SPRAYING EXPERIMENTS FOR SAN JOSE SCALE.

By T. B. Symons and A. B. Gahan.

INTRODUCTION.

The efforts of the different Experiment Station workers as well as private individuals to secure a cheap, effective and easily applied remedy for the San Jose scale and the continual placing of these results before the public, makes necessary constant experimenting with insecticides in order to verify the claims of merit made for these new solutions or treatments. We are always willing to cooperate with anyone who believes that he has discovered a better means of controlling this troublesome pest than those already in use, and to give any new preparation a fair trial, but we must be convinced of its merit by the results of careful experiments before a recommendation will be given. This is but justice to the orchardists of the State.

The past year has witnessed the introduction of several new spray mixtures, and as far as possible, each has been carefully tested experimentally in the hope of finding a more practical remedy than the present lime, sulfur and salt mixture and that we might be able to give to inquiring fruit-growers information based upon personal observation regarding these new preparations. This bulletin is a summary of the results of these experiments and should be carefully read by all those having orchards in need of treatment.

In this connection it is hardly necessary to repeat here what has already been stated in former bulletins of this Station, that the spraying of trees for this pest must now be considered as a part of the general routine of orchard work. That it can be profitably done is witnessed by the increasing number of orchardists who are spraying every year with satisfactory results and who are fully convinced that it must be done if fruit growing in Maryland is to maintain its high rank among the other industries of the State. The value of spraying is also proven by the sad experience of the many apple and peach growers who have lost their trees through failure to treat.

LIST OF EXPERIMENTS.

The experiments for the past year comprise tests with the kerosene limoid; lime, sulfur and salt mixtures, together with the patent insecticides; Kill-o-scale; Scalecide; Horicum and Consol. In all about 1416 trees were treated including both peach and apple. The results of the lime, sulfur and salt experiments will be used as a basis of comparison for the others.

The trees treated were located as follows: 516 peach trees on the place of Mr. R. O. Shipley, Harmans, Md.; 150 peach trees in the orchard of Mr. F. I. Waters, Patuxent, Md.; 100 apple trees at Elvaton, Md., belonging to Mr. E. Wade; 325 peach trees near Cambridge, Md. on the place of Mr. C. L. Sewards; 300 apple trees at Laurel, Md. on the farm of Mr. J. B. Ennis in cooperation with the Bureau of Entomology, U. S. Department of Agriculture, and smaller lots on the place of Dr. Jos. R. Owens, Hyattsville, Md.; Dr. S. S. Buckley, College Park, Md., and Mr. Miller, College Park, Md. We are greatly indebted to each and all of the above named gentlemen for their courtesy and cooperation.

KINDS OF SPRAY SOLUTIONS USED AND RESULTS OBTAINED.

Experiment I. (a) *Kerosene Limoid, 20%*

This spray solution was first brought to our attention in 1904, and gave promise of becoming a good substitute for the lime, sulfur and salt. Although slightly more expensive it is easily prepared, requiring no cooking, and it was thought that the mechanical mixture of kerosene and limoid (a hydrated lime) would prove effective against the scale without the attending danger of injury to the trees from the kerosene. This mixture was prepared and applied according to the directions of those recommending it. The experiment comprised thirty-six badly infested apple trees at Elvaton, sprayed December 23rd, 1904. A like number of peach trees at Patuxent, sprayed March 23rd, 1905, and forty peach trees at Cambridge, sprayed April 1st, 1905.

Unfortunately no trees were treated with the lime, sulfur and salt at Elvaton, so no comparison can be made between the two washes as winter treatment at this place, but checks were left which give a fair test of the efficiency of the wash. At both of the other places, plats were sprayed with the normal lime, sulfur and salt, and good comparisons were afforded. Examinations made in from three weeks to a month after treatment of each plat, showed that a considerable per cent. of the scale had been killed, but the final examinations in the early fall demonstrated that the wash had interfered very little with the breeding of the scale during the summer, the treated trees being nearly as badly infested as were the checks. On the other hand at the places where the lime, sulfur and salt plats were available for comparison a marked contrast was evident, the trees treated with the latter wash being in excellent condition.

(b) *Kerosene Limoid, 25%*

This strength was applied to fourteen apple trees at Elvaton, ten peach trees at Patuxent, and twenty-five peach trees and three apple trees at Cambridge, on the same dates respectively, as the above mixtures. The examination showed a slightly more satisfactory effect, but in no case were the results comparable to those with the lime, sulfur and salt.

While the results of these experiments with this mixture were a disappointment to the writers, they seemed to be quite conclusive, as regards its inefficiency as a winter wash, but further experimentation may prove it available as a summer treatment.

Experiment II. Lime, sulfur and caustic soda (20-15-12) *without cooking.*

This solution was applied March 3rd, at Harmans, to test two different methods of preparation; one combining the sulfur and caustic soda first, and pouring this solution with the slacking lime, the other by slacking the lime and sulfur together and adding the lump caustic soda gradually. Twenty-five trees were sprayed with each of these solutions.

Examinations in early fall showed that both washes were fairly satisfactory, although not as good as either the boiled lime and sulfur, or the lime, sulfur and salt washes.

Experiment III. Lime and sulfur (20-15) *boiled* 45 *minutes.*

The object of this was to determine the usefulness of salt in the lime, sulfur and salt mixtures. About 140 trees were sprayed with this mixture, March 14th, 1905, at Harmans, and sixty peach trees April 3rd, 1905, at Cambridge. Previous tests in 1903 and 1904 did not demonstrate conclusively that the salt was an unnecessary ingredient of the lime, sulfur and salt solution, but our experiments the past year furnish further evidence of the effectiveness of this wash without salt.

Experiment IV. Lime, sulfur and salt (20-15-12 *boiled* 45 *minutes*).

As stated previously this experiment was conducted for the purpose of furnishing a comparison for estimating the effectiveness of the various washes. About 120 peach trees were treated March 14th, 1905, at Harmans; 61 on March 24th, at Patuxent; 62 on April 4th, at Cambridge; 15 on April 11th, at Hyattsville, and 300 apple trees on March 5th, 1905, at Laurel, the latter conjointly with the Bureau of Entomology, U. S. Department of Agriculture.

All of these experiments have given very good results and bear out our previous recommendations.

Experiment V. Kill-o-scale 1 *part to* 18, 20, 22 *and* 25 *parts of water respectively.*

Forty apple trees were treated 1 to 18 and 1 to 20, December 24th, 1904, at Elvaton: 160 peach trees 1 to 18 and 1 to 22, March 15th, 1905, at Harmans; 135 at 1 to 20 and 1 to 25, April 4th, 1905, at Cambridge, making in all 290 peach trees and 40 apple trees sprayed with the different strengths of this preparation. An examination of these plats in early fall showed all of them to be very badly infested demonstrating that one application of this wash applied at the above strengths, as recommended by the manufacturer, cannot be considered to be an effective winter or spring treatment for the San Jose scale.

Experiment VI. Consol, 1 *part to* 20 *parts of water.*

This preparation was applied on 28 apple trees at Elvaton December 24th, 1904, and 14 peach trees at Harmans, March 15th, 1905, and 16 peach trees at College Park, April 10th, 1905. The above formula 1 to 20 is according to the directions of the manufacturer, and at this strength the preparation proved unsatisfactory as an insecticide for the control of the scale, as the early fall examinations revealed the treated trees in about the same conditions as the checks.

Experiment VII. Scalecide or Anti-scale, 1 *part Scalecide to* 19 *parts of water.*

Fifteen trees at Harmans and six trees at College Park were sprayed with this solution March 16th, 1905, and April 10th, 1905, respectively. All of these trees were only moderately infested with scale when the application was made. As with the foregoing preparation the early fall examination showed that the scale on these trees has bred freely during the summer so that the trees are now in worse condition than before treatment.

Experiment VIII. Horicum.

On April 10th, 1905, eight peach trees, five apple trees and five plum trees at College Park were sprayed with this preparation. These were badly infested at the time of application, and at the time of the fall examination showed no improvement, some being nearly dead.

RECOMMENDATIONS.

As in bulletins 90 and 99, respectively, we must continue to recommend the lime and sulfur mixtures as the most satisfactory for spraying for San Jose scale. Our experiments the past year have demonstrated more fully than ever before the superiority of these washes in controlling this pest. Where cooking is possible either lime, sulfur and salt or the lime and sulfur without salt is preferable to the cold mixture. Where cooking the lime sulfur mixtures by fire is not practicable it is possible to make a fairly satisfactory solution by the use of caustic soda.

Formula for Lime and Sulfur Wash.

Good quality of freshly burnt stone lime....	20 pounds.
Flowers of sulfur........................	15 pounds
*Common Salt	10 pounds.
Water	50 gallons.

Directions:

Put 20 gallons of water in an iron pot or hog scalder and bring it to a boil, and then add the stone lime and sulfur. The sulfur should be made into a paste with hot water before placing it in the boiler in order to facilitate its mixing. *After the lime and sulfur have been boiled for some time, add the salt. Boil the mixture, stirring occasionally, from thirty minutes to one hour or until the sulfur is thoroughly dissolved and produces a clear amber colored solution. Then dilute by adding sufficient hot or cold water to make fifty gallons. Pass the mixture through a strainer with at least twenty meshes to the inch, into the spray barrel and apply to the trees warm.

In treating badly infested apple trees where only one application is made, better results may be secured by increasing the sulfur and lime each five pounds more than given in the formula above.

Lime, Sulfur and Caustic Soda.

When it is impracticable to cook the solution as described above, one can be made as follows without cooking, which will be fairly effective.

Formula:

Good quality freshly burnt stone lime......	20 pounds.
Flowers of sulfur	15 pounds.
Caustic Soda	10 pounds.
Water	50 gallons.

Directions:

Mix the sulfur with a small amount of water to form a paste then add the lump caustic soda gradually to the sulfur paste. When the sulfur is all dissolved, pour this solution with enough water to keep from burning upon the stone lime, and allow the same to thoroughly slack, keeping the heat confined as much as possible by placing a sack over the barrel. Dilute with cold water to make 50 gallons and stir into the spray barrel.

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*Note. While we do not consider salt a necessary ingredient to the wash yet the amount as given above can be used if desired.

TIME OF APPLICATION.

While the lime and sulfur washes are considered as a treatment for dormant trees, our experiments indicate that where only one application is made, the treatment should be deferred until as late in the spring as possible, owing to the fact that the effectiveness of the wash depends to a great extent upon its presence on the trees, after the breeding season begins. However, in cases of bad infestation it is best to give the trees two treatments one in the fall and the other in the spring. We have found that the wash can be safely applied to trees in the spring after the buds have begun to open.

MODE OF APPLICATION.

For applying the solution select a good spray pump that has all its working parts brass and furnishes a constant high pressure. Use any of the nozzles that are suitable for applying Bordeaux Mixture.

The spraying is somewhat disagreeable, and the solution is slightly corrosive so that the man doing the work should be provided with rubber or oil skin coat, hat gloves, and a pair of goggles. It is a good plan to rub some vaseline on the hands and face to prevent the spray from irritating the flesh. The horses should be covered with blankets or old sacks. The aim should be to spray thoroughly and see that every part of the tree is covered. In order that this may be done with facility, the hose should be long enough to enable the man to reach all sides of the tree without moving the barrel. Trees which have been thoroughly sprayed present a whitened appearance when dry. After drying it is easy to detect the parts that have been missed, and these should be gone over.

There are a great many kinds of spray pumps on the market and each person must select that which suits his taste and needs.

The following are manufacturers and dealers in pumps and supplies:

F. W. Bolgiano & Co., 935 B St., Washington, D. C.
Field Force Pump Co., Elmira, N. Y.
Goulds Mfg. Co., Seneca Falls, N. Y.
Griffith & Turner Co., Baltimore, Md.
Morrill & Morley, Benton Harbor, Mich.
Myer Pump Co., Ashland, Ohio.
L. G. Orndorff, 203 7th St., N. W., Washington, D. C.
Spray Motor Co., Buffalo, N. Y.
Geo. H. Stahl. Quincy, Ill.
The Deming Co., Salem, Ohio.

THE MARYLAND

AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 108. APRIL, 1906.

IRISH POTATO DISEASES.

J. B. S. NORTON.

This bulletin is prepared to meet a demand for information on Irish potato diseases. The matter contained in it is taken from observations on potato diseases in this State, compared with previous work at this Experiment Station and of investigators in many other places. Especially has the work of the New York and Vermont Experiment Stations, and of the United States Department of Agriculture, been used in this treatise, which endeavors to give a brief, but full account of health and disease in the Irish potato, as related to Maryland conditions.

GENERAL CONDITIONS OF HEALTH.

Considered from the farmers' standpoint the potato plant is a machine for the production of starch, the principal constituent of the potato, together with the small amount of other substances combined with it in these enlarged under-ground stems, which we use as food. The raw material for the potato substance comes from the soil water, taken up by the roots and the gases of the air. While the sunshine and other conditions are favorable these substances are organized in the leaves, and gradually pass downward, and accumulate as starch below ground. Since such important work is done by the slender fibrous roots and the expanse of leaves exposed to the sun, the necessity of keeping these organs in good working condition is easily seen. And theoretically one might say that the more water passed through the plant from the roots, and the more sunshine received by the leaves, the more potatoes produced.

The ideal conditions for healthy growth are loose, rich, well-drained, but moisture-retaining soil of moderate coolness, rich in humus, and used in rotation with legumes. Heavy soils are not so good as light and need to have careful management. Constant moisture is the first consideration, but wet soil is equally as fatal to good growth as drought.

Rapid and constant growth gives the best quantity and flavor, though the latter varies with the soil. And the fundamental conditions must be kept up by proper cultivation, especially in the critical period in the life of the potato plant, just after the blossoms appear, when the strength is going into the formation of tubers. If the leaves can be kept healthy then, the life can be prolonged many weeks, and the yield correspondingly increased.

SEED WITH REFERENCE TO HEALTH.

After considering suitability for desired use in earliness, production and quality, the variety planted should be selected for resistance to drought, disease, insects, etc. And if it is desirable to grow one's own seed each season, the stronger, more productive and resistant plants should be picked out for seed, thus keeping up or improving the vigor of the stock. The vigor and health of the plant, which bore the seed tubers, has more to do with their success than the size of the tubers used for seed, or how they are cut.

Partly rotten potatoes or those showing any imperfections, indicating lack of vitality, should never be planted, as they are apt to communicate diseases to those that grow from them, and the cleanest, most healthy-looking seed possible should be used. One poor potato saved by planting it, is usually equivalent to throwing away a whole hill.

The weakening of the seed by too early sprouting has to be carefully guarded against, and may be done by careful storing, or by the use of northern seed. The object of the starch in the potato is to feed the young plants until they can get well-rooted, and they must suffer if it is exhausted by sprouts that are lost before planting. The cut seed may be injured by drying out, or heating, if kept more than ten days before planting. The partly dried pieces withstand rot better if planted in wet soil.

As the country becomes older, parasitic diseases and insects multiply. While in the great potato lands of the West, the plant grows luxuriantly, and is but little injured by blight or insects; here these often cause the loss of one-half of what the land would produce without them. And we have become so used to this loss that we do not see the damage, and count this half crop a full crop. The estimated loss from potato diseases in Maryland in 1904 was fifteen per cent. of the crop, and when, as statistics show, our average yield per acre is only seventy bushels, when hundreds of bushels are possible, it is of great importance that something should be done to increase the yield.

There are several different diseases caused by different germs or fungi. These are often confused and though usually distinguished as blight, rot and scab, there are several kinds of blight, also of rot and

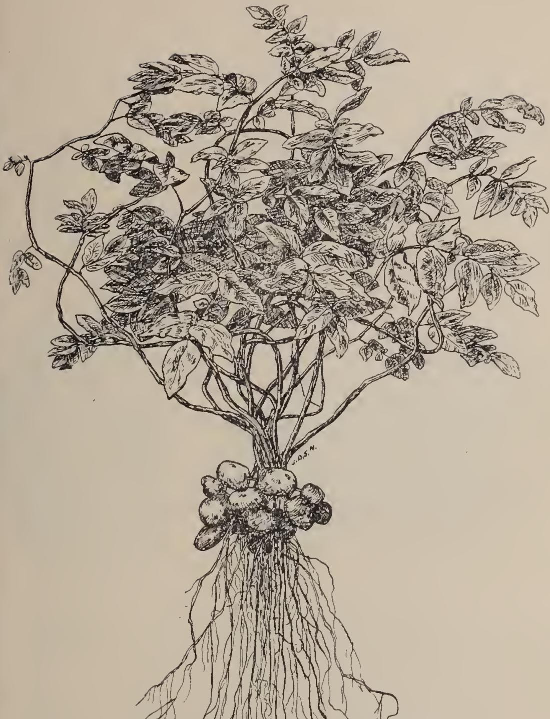


FIG. I.—ENTIRE HEALTHY POTATO PLANT (COPY, AFTER COBURN).

scab; each due to a different cause, and often needing entirely different treatment. The following pages gives some account of the diseases most common here.

SCAB.

The diseased condition known as scab causing roughened, scabby surfaces on the tubers, is mostly caused by a minute parasitic fungus, *Oospora scabies.* The fungus also lives in the soil from year to year. Alkaline conditions of the soil favor the growth of the scab fungus, so that lime and fresh stable manure, though valuable in increasing yield, are to be used with caution and, perhaps, are better applied to the previous crop. Lime also favors rot. If the soil to be planted is infected with scab, some green manuring might be sown in the fall, and turned under in the spring, to give acidity to the soil. Experiments in New York, however, failed to show beneficial results from green manuring to reduce scab.

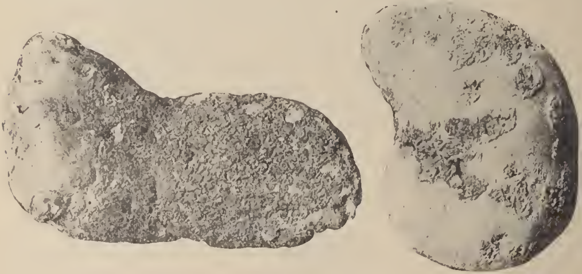


FIG. 2.—SCAB ON POTATOES. (PHOTO. BY F. H. BLODGETT).

If seed potatoes free from scab cannot be had for planting, the seed can be disinfected before planting, by the use of either of the following methods; then if planted in scab-free land, the resulting crop will be practically free from the disease. The seed potatoes may contain scab germs though they appear perfectly smooth:

1. Two ounces of corrosive sublimate, dissolved in hot water and diluted with cold water to fifteen gallons. Suspend the previously washed uncut potatoes in a coarse sack in this solution for one and a half hours, using a wooden vessel as it acts on metals. This substance is very poisonous and the treated potatoes should not be eaten by anything. After soaking the potatoes are dried, cut and planted as usual.

2. Mix eight ounces (one-half pint) of commercial formalin (40 per cent.) with fifteen gallons of water, and use as the other

solution, but soak for two hours. Formalin is poisonous, but not so dangerous as corrosive sublimate; it also soon evaporates, and does not remain on the tubers as the sublimate does.

Either of these may somewhat retard the germination, and will injure the sprouts that have already started. Fifteen gallons is enough to disinfect twenty to twenty-five bushels. Of course, if the seed is planted in scabby land, the treatment will lose most of its efficiency.

Rolling the cut potatoes in sulfur, before planting, has also been used to control the scab, but is more expensive than the solutions, and is often of little value. The sulfur helps the cut pieces to keep longer, and prevents rotting in prolonged wet weather after planting. Also scattering sulfur in the rows is used by some to destroy the scab germs in the soil, but usually it does little good. Also dipping in Bordeaux mixture has been used.

In Vermont formaldehyde gas has been used with as good success as the liquid formalin to control scab. Its use is often more convenient.

Certain varieties as Cambridge Russett in particular, and also Carmen No. 3, American Giant, Sir Walter Raleigh, Irish Cobbler, Scab Proof and Aurora, are recommended as resistant to scab.

There are several less common scab diseases caused by other fungi and bacteria.

RHIZOCTONIA.

Small brown bodies not easily removed by washing often seen on potato tubers are caused by a fungus, Rhizoctonia or Corticium. As a rule they do not seem to cause much damage. But in Ohio a disease called "rosette," causing stunted growth and premature death of the potato plant, is ascribed to this fungus, and in Colorado a trouble called "little potatoes," is found associated with this fungus, which there also attacks the main stem of the plant near the surface of the ground.

The formalin treatment given for scab has been recommended for this; also the planting of clean, well-formed tubers.

DRY ROT.

This disease is caused by a fungus, *Fusarium oxysporium,* which growing in the stem causes the plants to gradually dry up and die. The disease is indicated by the lighter colored and more or less rolled up leaves. When dug the potatoes may appear sound, but internally show black or brown streaks, and later are destroyed at least at one end by the dry rot.

The fungus may remain in the soil for a long time, and badly affected land may have to be abandoned for potato growing for several years. The affected tubers should not be used for seed.

BROWN ROT, BACTERIAL WILT OR WET ROT.

This disease is caused by bacteria (*Bacillus solanacearum*), which are introduced into the plant through the bites of the Colorado beetle, flea-beetles, etc., and multiplying cause the leaves and stems to wilt and shrivel and working down into the tubers cause a wet rot. The same germ attacks egg plant, and causes the Southern blight of tomato, so destructive in the southern part of Maryland.

Very thorough and persistent spraying, using Bordeaux mixture with arsenites to prevent the action of the insects, such as flea-beetles and the common potato bugs, which scatter the germ, and to kill the exposed bacteria themselves, is the best treatment, although not perfectly effective. The affected tubers should be dug early, and if stored they must be kept in a cool, dry place to keep back the rot. In planting avoid land that has recently borne tomatoes, potatoes, or egg plants affected with this disease.

Soft rot or wet rot may develop in potatoes kept in moist and warm places, through the action of various bacteria and fungi. A large percentage of the crop is often lost from wet weather before digging time. This might be obviated by early digging, but there is also danger of rot if dug early and stored, unless some cooling is available. In handling as much bruising as possible should be avoided as the broken epidermis allows rot-germs to enter.

EARLY BLIGHT.

This disease is caused by the growth of the fungus *Alternaria solani* in the spots on the leaves. It appears before or about the time the tubers begin to form, or when anything else lowers the plant's vitality, and is indicated by grayish brown spots, with faint concentric circles like target marking on the leaves. These spots gradually become larger and in ten days, half of the leaf may be brown and withered, and the rest of an unhealthy yellow color, though the stems may remain green: or the disease may progress more slowly. Of course the tubers stop growing as the leaf-surface is destroyed, and the crop is cut short. This early death of the leaves is often so common that it is thought to be the natural ripening of the vines. But when sprayed vines live many weeks longer and produce a much larger crop, the difference is readily seen.

The treatment is thorough spraying with Bordeaux mixture. A mist like spray should be put on all parts of the vine, Paris green being added to kill the insects.

The McCormack potato now much grown in Maryland seems decidedly resistant to this disease.

A bacterial disease known as black leg is common on the potato stem in Europe, but if it occurs in America it is not common.

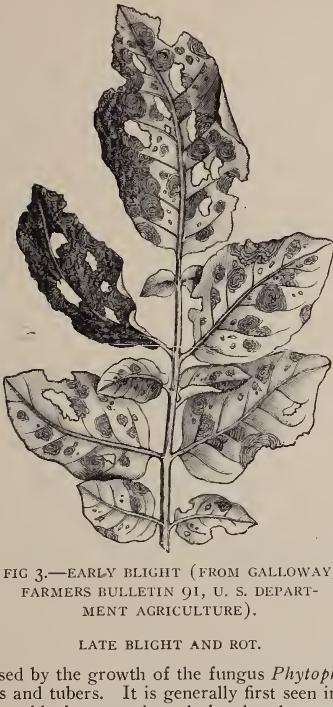


FIG 3.—EARLY BLIGHT (FROM GALLOWAY, FARMERS BULLETIN 91, U. S. DEPARTMENT AGRICULTURE).

LATE BLIGHT AND ROT.

This is caused by the growth of the fungus *Phytophthora infestans* in leaves, stems and tubers. It is generally first seen in moist weather in summer, as suddenly appearing, dark-colored areas on the leaves, which become soft and bad smelling. It sometimes appears so suddenly and spreads so rapidly that a green field may, in two or three days. look like it had been burned over, the blighted leaves dying and leaving the bare stems. It is estimated that in New York this disease caused the loss of $10,000,000 worth of potatoes in one year. The disease may later appear in the tubers causing them to be black and brown streaked and to rot. Other diseases may cause similar affects on the tubers.

This disease is not commonly destructive in Maryland, as the summer temperature is not usually sufficiently low for a long enough time for the development of the parasite, though it has caused serious loss in many parts of the United States since 1840, and has been destructive at times as far south as Florida, being no doubt introduced on northern seed.

The treatment is preventative spraying with Bordeaux mixture and avoiding the planting of decayed or discolored tubers, which carry the disease over winter. Deferring digging as long as possible, reduces loss from rot in storage. The average increase due to spraying for this disease for fifteen years in Vermont, is 119 bushels per acre, or sixty-eight per cent.

The investigations of Jones show that although no varieties are proof against this disease, some are much less affected by it than others. Early varieties may mature soon enough to escape the disease, but if planted late may blight worse than others. Highly nitrogenous fertilizers lower resistance to late blight. Varieties rich in starch rot less from late blight than those rich in protein. Those with red, thick, rough skin rot less than thin-skinned white varieties. Varieties with hard, rough stem and small, rough, dark-colored leaves, blight less. Some of the American varieties less subjected to blight are Dakota Red, Rust-proof, Irish Cobbler, Sir Walter Raleigh, Doe's Pride and White Beauty, and some others not so thoroughly tested that have recently been introduced.

INJURIES NOT CAUSED BY PARASITES.

The internal brown spot disease frequently noticed in the flesh of the tuber is apparently not due to parasites, and may be due to cultural conditions, being worse on light, dry soils or those lacking lime and potash. Some varieties seem more susceptible to it. It would be better to not plant potatoes so affected.

The leaves are often injured by weather conditions, and effects similar to early blight produced. Dry, hot weather with lack of water in the soil will cause *tip burn*, which is the death and drying of the leaf margins, and sometimes spots away from the leaf edge especially where punctures of flea-beetles have caused loss of water. Too deep late culture will induce it. The name *sun-scald* is applied to similar effects due to hot sunshine after a period of wet, cloudy weather.

Plants in good, well cultivated soil and sprayed with Bordeaux mixture are less liable to tip burn. Irrigation would be helpful when it could be practiced.

The leaves are frequently injured by poisoning with Paris green, applied dry, or even with water only, giving an effect resembling early blight, especially where flea-beetles occur. By using the arsenical poisons with lime-water, or better Bordeaux mixture, this injury is obviated, as well as great benefit gained from the protection against fungous diseases which the Bordeaux affords. Many farmers use Paris green alone in a very wasteful and injurious manner, and frequent cases of supposed blight are nothing but Paris green injuries. One pound per acre at each spraying is enough.

Light causes a somewhat poisonous substance found also in sprouted potatoes, to develop in the outer layers of the potato: such tubers turn greenish and are strong flavored, and unfit for food.

Frozen potatoes have a sweetish flavor, due to the conversion of some starch into sugar.

NOTES ON SPRAYING POTATOES.

Many tests have shown that the best material for spraying potatoes for leaf diseases and insects, is Bordeaux mixture, containing Paris green. It may be made as follows:

Five to six pounds copper sulphate (blue stone), dissolved in twenty-five gallons of water; four to six pounds of fresh stone lime, slacked as for white-wash in twenty-five gallons of water; one to two pounds Paris green; mix thoroughly and use fresh.

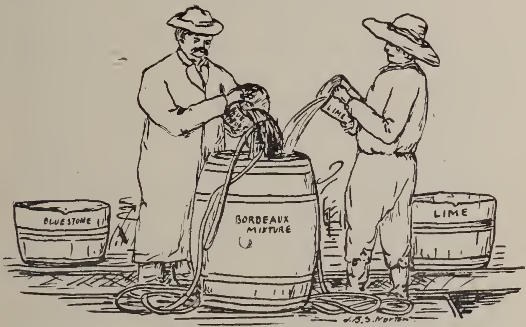


FIG. 4.—MAKING BORDEAUX MIXTURE.

The useful part is the copper, the lime is added to prevent its injuring the foliage. The best mixture is that which settles out most slowly. It is best made by taking the cold diluted milk of lime and copper sulphate solutions and pouring them together through a strainer into the sprayer, as shown in figure 4. The Paris green can be added at the same time.

Properly made Bordeaux mixture is of a brilliant sky-blue color, or lighter as more lime is added. If the lime is poor it will have a greenish cast. If there is insufficient lime in the mixture it may injure the foliage. A test of this can be made by dropping a little yellow prussiate of potash (very poisonous) into the mixture. If the drops turn reddish brown, add more lime until the test repeated shows no change. A considerable excess of lime will do no harm and is necessary for spraying some sensitive things like peach foliage. Blue litmus paper can also be used as a test; it turns red if there is not enough lime in the mixture.

When spraying is done on a large scale "stock solutions" of the copper sulphate and lime should be made up by adding one pound of lime to each gallon of water in the lime stock barrel, and one pound of copper sulphate to each gallon in the copper sulphate stock barrel. These will keep indefinitely if not allowed to evaporate, and the mixture can be easily made by taking as many gallons of each as the formula calls for pounds, and dilute and pour together as before.

If one has a suitable water supply pipes and faucets to barrels on an elevated platform can be arranged to save labor of handling the liquids. They can also be piped together into the sprayer and thus mixed if always first diluted.

The ordinary barrel pump, costing about fifteen dollars, is one of the best arrangements for potato spraying, one man pumping and driving the cart or wagon, and two others working the nozzles. Or with a little more expense a set of pipes, with nozzles attached, in the proper position to spray four rows at a time, can be arranged so that one man can do all the work, though less effectively; for larger fields geared pumps of similar structure to the last mentioned are used, and the labor is done by the horse, but they are more expensive ($60 to $75), and do less careful work. It is essential to good work to have a pump and nozzle that will make a fine mist, and not simply sprinkle the plants.

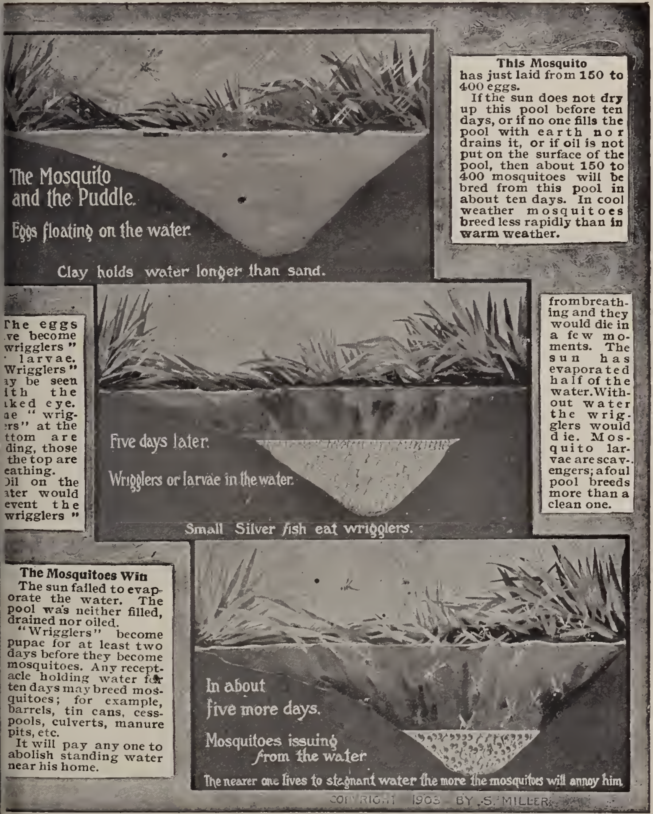
Spraying probably would not be very profitable here on early potatoes. Wherever late blight does damage it would pay well. Three years tests of spraying potatoes at this Experiment Station, showed an average increase of fifty-two per cent. on the sprayed fields, spraying three or four times from June to September. On late varieties when no blight was present, experiments in New York show a net profit of $11 per acre, when potatoes were only twenty-five cents per bushel.

It will cost $4 to $6 per acre to give five applications of the spray per season to potatoes. This includes labor for man and team and wear on sprayer, labor being estimated at seventeen and one-half cents per hour, which is more than is usual in this State. Here we could usually spray at a cost of less than one dollar per acre for each spraying. Labor is the principal expense, after the spraying outfit is secured, as the materials cost comparatively little.

As a general rule commence spraying when the plants are six to eight inches high, and give four to five sprayings at intervals of about two weeks. When the blossoms begin to come the plants should be kept covered with Bordeaux mixture until they have completed their growth.

The application of Bordeaux mixture aside from preventing parasitic diseases, and repelling flea-beetles causes the plants to make a better growth, probably by protecting the foliage from the intense summer light and heat, and so is of value even when no disease is present.

INFORMATION ABOUT MOSQUITOES.


The Mosquito
and the Puddle.
Eggs floating on the water.
Clay holds water longer than sand.
Five days later.
Wrigglers or larvae in the water.
Small Silver fish eat wrigglers.
In about
five more days.
Mosquitoes issuing
from the water.
The nearer one lives to stagnant water the more the mosquitoes will annoy him.

This Mosquito
has just laid from 150 to 400 eggs.

If the sun does not dry up this pool before ten days, or if no one fills the pool with earth nor drains it, or if oil is not put on the surface of the pool, then about 150 to 400 mosquitoes will be bred from this pool in about ten days. In cool weather mosquitoes breed less rapidly than in warm weather.

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from breathing and they would die in a few moments. The sun has evaporated half of the water. Without water the wrigglers would die. Mosquito larvae are scavengers; a foul pool breeds more than a clean one.

The Mosquitoes Win

The sun failed to evaporate the water. The pool was neither filled, drained nor oiled.

"Wrigglers" become pupae for at least two days before they become mosquitoes. Any receptacle holding water for ten days may breed mosquitoes; for example, barrels, tin cans, cesspools, culverts, manure pits, etc.

It will pay any one to abolish standing water near his home.

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NOTE—The above illustration is a correct representation of the breeding of the commonest of our domestic mosquitoes (Culex pipiens). The story of this puddle is the story of a million puddles. The sun may usually be depended upon to dry up the great majority of such puddles before ten days elapse. From Smith "Report on Mosquitoes, State of New Jersey," and the South Orange, N. J., Village Improvement Society.

THE MARYLAND
AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 109. MAY, 1906.

THE MOSQUITO.

By Thos. B. Symons, T. H. Coffin and A. B. Gahan.

The comparatively recent discoveries of the transmission of diseases, particularly malaria and yellow fever, by certain species of mosquitoes makes the investigation of their character and characteristics in Maryland of great importance from the human standpoint. This phase of the problem should strongly appeal to every one, as an epidemic of these diseases can never be foretold. A striking illustration of the effectiveness of the mosquito control in connection with these diseases has recently been shown in New Orleans. In addition, the increased value of property along the bay shores and lowlands of the State which would necessarily follow a thorough draining of such lands in the course of eradication of the breeding places of mosquitoes, would add much to the wealth of the respective counties. This of itself should be sufficient compensation for conducting such work. The great success achieved in other States, notably in New Jersey and New York, in eradication of the pest in localities systematically treated, should be an incentive for similar work in this State.

The inauguration of these investigations was accomplished through the co-operation of Dr. Howard A. Kelly, of Johns Hopkins University, who has been untiring in his efforts to have such work done in and around Baltimore City by contributing towards the employment of an assistant in the work. The services of Dr. T. H. Coffin, who had previously done considerable work with mosquitoes with the Bureau of Entomology, United States Department of Agriculture, were secured to assist in this work. Acknowledgment is hereby made to Dr. L. O. Howard, Chief of the Bureau of Entomology, and to Dr. J. B. Smith, of New Jersey, for the loan of several cuts of various species of mosquitoes, and especially to Dr. D. W. Coquillett for determining various species.

This preliminary report will show the great importance of our investigating this problem further and inaugurating experiments, if they may be called such, towards the eradication of breeding places and the treatment of stagnant waters and cisterns. The great amount of land in the State which offers only breeding places for these pests makes this one of the most important entomological problems of Maryland, not only on account of the annoyance to the inhabitants, but also on account of the health of the State.

Thos. B. Symons, *Entomologist.*

THE MOSQUITO PEST.

By T. H. Coffin.

INTRODUCTION.

Mosquitoes have, for ages past, forced themselves upon the attention of the human race, and, according as their number was large or small, have been considered merely as a necessary nuisance prevalent during certain seasons of the year, or when their numbers have been considerable, they have been looked upon as a very serious pest both to man and animals.

According to Howard, there are historical instances in which mosquitoes have been the cause of the abandonment of homes or villages, because of their number and insatiable thirst for blood. The historian relates that Sapor, King of Persia, had to raise the siege of Nisibus on account of a plague of gnats (mosquitoes) attacking men and elephants and beasts of burden.

Again, the Russian soldiers near the Crimea had to sleep in sacks to protect themselves from swarms of mosquitoes, and some died from gangrene produced by their bites.

Some localities are uninhabitable on account of mosquitoes. In the State of Washington the common mosquito is a fearful nuisance from its great numbers in the summer months, and it is necessary to establish a line of smudges before going into camp.

In some parts of Montana work horses must be sheathed in sheets during the day to protect them from the bites of these bloodthirsty insects.

In Corpus Christi great herds of horses ran before mosquitoes to get to water, where they submerged themselves to gain relief from their tormenting bites.

Dr. Riley states that a brave man on a fleet horse dares not to cross some of the prairies of Minnesota in June, while the marshlands of New Jersey, the Adirondacks and the hills of Long Island have become notorious, because of the abundance and ferocity of these little pests.

The opening of the Alaskan gold fields has brought out the fact that during the summer months certain parts of the country are almost uninhabitable, on account of the fearful pest of mosquitoes.

In Maryland there are regions where mosquitoes become a great pest, and there are few localities absolutely free from them. Not only is the extermination of mosquitoes important from the standpoint of their being pests and nuisances, but certain species are concerned directly in the spread of malaria and yellow fever.

Only in recent years has the mosquito question received careful study, and our present knowledge is due to the interest aroused by discoveries regarding these diseases. In any region where the mosquito pest is to be regulated, it is necessary, first, to find what species are prevalent, their breeding places, distribution, habits and power of flight. It was with these points in view that the preliminary work was undertaken in the summer of 1905.

The term mosquito includes a great many different species, and the habits of the various species differ greatly.

MOSQUITOES AS CARRIERS OF DISEASE.

Two diseases, yellow fever and malaria, are now known to be conveyed by the bite of certain mosquitoes, and it is quite certain that these diseases are incurred in no other way. Fortunately, we are able to recognize the dangerous species from certain markings, which are absolutely characteristic.

Our knowledge of the mosquito as a disease carrying agent is of comparatively recent date, for less than a dozen years ago the cause of these diseases was unknown, though a number of years ago elephantiasis was thought to be caused by the mosquito. Two thousand years ago Roman writers, Varro, Vitruvius and others, stated that mosquitoes bore a causal relation to malaria.

As early as the second century a Sanscrit writer said that mosquitoes were concerned in the spread of epidemics.

A few writers in the past century referred to the mosquito as a possible source of disease; but the establishment of our knowledge on the subject is due to the investigations of Manson and Ross in England, who, in 1898, showed positively that malaria is transmitted by the mosquito. Formerly this disease was thought to be caused by some mysterious vapor, or poisonous gas, emanating from the soil in the vicinity of swamps and diffusing itself into the air and that when human beings became exposed to this air they were infected with the disease. This idea is borne in the word malaria, which in Italian, means bad air. Epidemics were supposed to be caused by the dissemination of the "bad air" by winds.

In 1880 Laveran, a surgeon in the French Army at Algiers, made an epoch-making discovery, when he found the parasites of malaria in the human blood. How the parasites gained access to the body was a mystery. It was suggested that it entered the respiratory tract or occasionally was taken into the body in drinking water. Celli, an Italian observer some years after Laveran's discovery, noted the occurrence of great swarms of mosquitoes coincident with the outbreaks of malaria, which led him to suppose that the mosquito was in some way concerned with the spread of the disease.

MALARIAL FEVER.

It has now been shown conclusively that the malarial organism is transmitted from one person to another through the agency of a certain mosquito, the Anopheles. In biting, this mosquito draws into its body some of the organisms which go on to development in the insect's stomach, and if now the mosquito bites its next victim it injects some of these developed organisms into the wound with its salivary secretion. The organisms there reproduce and the person has an attack of malaria. Fortunately, the Anopheles mosquito differs from all others and is easily recognized. These differences will be shown in the discussion of the various species. (See Figure 6.)

The malarial mosquito is quite common in Maryland, four species being found here. These are: Anopheles punctipennis, Anopheles maculipennis, Anopheles crucians and Anopheles barberi. Of these four species Anopheles maculipennis seems to be the one principally concerned in the spread of malaria.

YELLOW FEVER.

Formerly this disease, like malaria, was looked upon as a mysterious pestilence, whose cause was unknown. The fearful epidemics that have occurred in this country led to a careful scientific study of the disease and to a search for its source and manner of transmission.

Various theories were advanced as to its cause. One most widely accepted was that the disease was due to decaying animal and vegetable matter, which in some way liberated into the air a poisonous or germ-laden vapor.

In 1896 Dr. Carlos Finlay, of Havana, after studying epidemics there, said that the mosquito was probably concerned in the spread of the disease. In 1900, during an epidemic in Cuba, a United States Commission was sent to study the disease and find, if possible, its cause and means of transmission.

Bearing the statement of Finlay in mind, this commission showed conclusively that the mosquito Stegomyia fasciata acts as an intermediate host. The specific organism has not yet been found; but from the investigations so far it seems probable that its cause is an ultra microscopic organism. In the experiments to prove that the mosquito transmits the disease the commission showed that a man might sleep in the same room with a yellow fever patient, wear his clothes and come in most intimate contact with him, and yet not contract the disease, if the room was mosquito proof. On the other hand, if a man was bitten by a mosquito infected from a yellow-fever patient the disease developed.

These discoveries led to an immense amount of work, all of which corroborated the first experiment. The epidemic of 1905 in New Orleans and the Southern States demonstrated again that the only way to control an epidemic of yellow fever is to fight the mosquitoes.

The yellow fever mosquito, like the malarial mosquito, is distinct from all other species and is easily recognized. It is the most abundant species in the Southern States. It becomes important in Maryland because it may be brought here from the South and in the summer months will develop rapidly. This fact should be borne in mind during yellow fever epidemics. It is usually found about the seaport towns and not far inland, being brought from the South by vessels or trains.

DISTRIBUTION AND ABUNDANCE OF MOSQUITOES.

In 1878 the number of known species in North America was 33, and in 1901 Dr. L. O. Howard stated that there were about 74 species in the United States. To date over 50 have been found in New Jersey and adjacent States, and in Maryland, at the time of this preliminary report, about 30 species have been found. Further work will show about the same species here as in neighboring States. The total number of species of mosquitoes in North America is now about treble that known 26 years ago. F. V. Theobald, in 1901, listed 343 species in the entire world, and in 1903, owing to active collecting and study, revised his list to include 430 species. At present we may expect at least 500 species in the world.

Geographically the mosquito is a widely distributed insect, being found in the far north, but more abundantly in the southern zones, the species of northern latitudes differing in some ways from those of the southern. In temperate climates there are found species common to both latitudes.

In considering the mosquito problem in any region three factors must be taken into account.

These factors may be classed as:

1. Climatic.
2. Topographical
3. Local conditions.

CLIMATIC CONDITIONS.

Regarding climatic conditions, Maryland, with its temperate climate, hot summers and rather abundant rainfall, may be expected to furnish a number of species of mosquitoes. The extensive waterways of the State and its low lying areas provide, in warm weather, ideal conditions for their development. The work of the past summer has shown that of the mosquitoes of Maryland some species are distinctly southern in their range, not being able to withstand the cold winters of States further north. Others have a northern distribution, since they may withstand severe winter temperature. Still other species found here are of wide geographical range.

TOPOGRAPHICAL CONDITIONS.

From a topographical standpoint the State offers many advantages for the development of mosquitoes. Regions situated at sea level, where streams are slow and sluggish, provide many breeding places. In such localities large bodies of water spread out over extensive areas, forming marshes and pools which are more or less permanent. The same conditions are brought about in other parts of the state, where there are extensive areas of level land, even though they may be at higher elevations above sea level. Here water may collect, forming pools or ponds, temporary or permanent, which afford admirable breeding places. These facts have a practical bearing upon the mosquito problem, since all species demand water for the successive cycles in their development. There are several species of salt marsh mosquitoes, which breed in such places as those mentioned near the tide level. The most important of these is the Culex sollicitans, a large mosquito and a ferocious biter, which is one of our most serious pests. This mosquito is widely distributed throughout the State, along the coast line, where the salt marshes are so numerous.

LOCAL CONDITIONS.

Local conditions in any part of the State are important factors in the prevalence of the mosquito pest. In country districts mosquitoes are found in abundance about any low lying areas, where water collects, forming pools more or less permanent. Woodland pools are found to be exclusive breeding places of certain species. The malarial mosquitoes are usually found in grass-lined pools, or pools which are protected from the direct rays of the sun. Hence, it is easily seen that they are widely distributed, for such pools are numerous in any locality. In or about towns, vacant lots or fields exist which contain depressions that fill up with water and persist for a week or ten days, giving ample time for the development of mosquitoes. These pools may be hidden from view; but when the mosquito pest becomes noticeable a careful search reveals the breeding place. (See plate 13—a breeding pool in a pasture.) About farm houses are numerous puddles and ponds which are usually overlooked as sources of mosquitoes. In towns or country districts other sources, and very fruitful ones, are found in the rain barrels, cistern and rubbish, such as tin cans, buckets, boxes, etc., which may catch rain water. Probably most people little realize that the "wrigglers" found in the water of rain barrels are the forerunners of the future mosquito pest. Just how this transformation occurs will be pointed out in the succeeding pages. Cisterns, discarded wells, leaky eaves-troughs, water tanks, tin cans and buckets become, during the summer months, fruitful breeding places for mosquitoes. All that is necessary is that they contain water for a week or ten days. Several species may be found developing in the same body of water, and a few days are sufficient for thousands of mosquitoes to come from a single source. When one realizes that the sources of this summer pest are so simple and easily remedied the question of mosquito extermination does not assume such large proportions as would at first be thought. Some authorities go as far as to say "Every householder breeds his own mosquitoes," and the statement is largely true, for most species do not fly more than a few hundred yards from their breeding places. *A quart can may furnish a sufficient number of mosquitoes to infest a neighborhood.*

LOCALITIES INVESTIGATED IN MARYLAND.

During the summer of 1905 special attention was paid to mosquito distribution in and about Baltimore. This part of the State shows a wide range of species, because of its position on the Chesapeake Bay and its shipping and export and import facilities. Mosquitoes may be carried on boats and trains for considerable distances. The yellow fever mosquito, when found in Maryland, is usually transported in this manner from Southern States and during the summer months may go on developing and reproducing. The mosquitoes of other parts of the State have been studied under direction of the State Entomologist from time to time, and the species in and about the District of Columbia have been studied by the Bureau of Entomology of the Department of Agriculture. The results of these various observations show that Maryland has the species described below. Further investigations should be made, for the habits of prevailing species must be known before attempts towards their control can be successful.

This article is merely written as a preliminary report on the mosquitoes of Maryland in order to show briefly what factors influence their prevalence, what species are common; also what species not encountered in the preliminary work may be expected to occur here in greater or less numbers.

HABITS OF MOSQUITOES.

The habits of mosquitoes have been well studied of late years and there is abundant literature on the subject, so that we shall not treat it at length. (See *Mosquitoes of New Jersey,* J. B. Smith; *Mosquitoes of New York,* E. P. Felt; *Notes on Mosquitoes of United States,* L. O. Howard.)

In the descriptions of the common species prevalent in Maryland we give some facts regarding habits, since the various species differ in this respect. The female mosquito is the one which is such a pest to mankind, for the male, not having mouth parts adapted to piercing the skin or sucking, seldom causes trouble. There has been some discussion as to whether blood is essential for the maturation of the eggs in the female, and it is probable that this question is to be answered in the negative, for mosquitoes abound in great numbers in some places where it is difficult to see how the female could obtain blood.

The food of adult mosquitoes is largely composed of plant juices, the male probably having no other food. The mosquito bites primarily to obtain food, and not maliciously. Giles says that high temperatures and humid atmospheres lead the females to bite for blood, when otherwise they would be satisfied with vegetable juices. They have been seen feeding on the catkins of the willow, blossoms of wild locust and wild cherry and on boiled potatoes and watermelons. The food of the female includes, besides human blood, that of reptiles, birds, bats and domestic animals. In captivity it feeds on the juices of apple, plum, pear and banana, showing a preference for sweet things. Pollen has been found in the stomach frequently, and often resembles the zygotes of the malarial parasites. Smith says that he has found the stomach filled with a mass resembling marsh mud.

The pain of the mosquito bite is not caused by the piercing of the skin by the fine lancets of the mouth parts, but by the irritating secretion of the salivary glands, which is poured through the proboscis for the purpose of thinning the blood and retarding its coagulation, so that it can be easily drawn into the mosquito's stomach.

Most species of mosquitoes fly only at dusk or at night, avoiding the bright sunlight and seeking shelter during the day in thick vegetation or cool, shady spots. About the house they can usually be found behind the beds, in dark closets, resting on dark clothing, or on the walls of a darkened room. While at rest in such a place the Anopheles assume a very characteristic position, enabling one to distinguish them from Culex without much difficulty. The species of the former genus rest with the tip of the abdomen elevated, and thus at an angle with the surface on which they rest. Species of the genus Culex, on the other hand, will be found resting with the abdomen on plane parallel to the one on which they rest. (See Figure 6 for illustration.) Some species bite viciously in broad daylight. The one most noticeable for this habit is Culex sollicitans. Psorophora ciliata and Anopheles crucians are also daylight fliers.

Most species begin to fly at twilight and continue until 9 or 10 o'clock. On humid, warm summer evenings they may be flying about until after midnight, and when indoors may remain active for most of the night. They become active again just before sunrise. Species differ as to power of flight, and males are rarely seen, except in warm, quiet evenings. C. sollicitans and C. cantator fly readily, even against a brisk wind. Smith says that C. sollicitans may fly five to six miles an hour against an ordinary wind and twice that in a mild wind.

Most mosquitoes, however, do not fly far and are not as strong as most other insects. It has been observed that during a strong wind trees and shrubbery may be filled with mosquitoes, which do not venture out until the wind goes down. Mosquitoes ceased to be troublesome when breeding places within 100 feet of human habitations were treated, although 200 feet away were pools in which mosquitoes were breeding abundantly.

Anopheles do not fly far—200 to 600 yards being the average distance.

VEGETATION AND MOSQUITOES.

Giles says that there are three essentials to the development of mosquitoes. (1) Vegetable food, (2) shelter from the sun during the heat of the day, (3) puddles. In 1 and 2 we have vegetation playing an important role, for the adult requires the plant juices for food and during the day it seeks shelter in bushes and trees and grass. The delusion was formerly prevalent that mosquitoes breed and live in grass, because swarms of mosquitoes often fly up when one walks through a thickly grown grass plot, and often mosquitoes are found in large numbers about the deep foliage of vines or a thick woods. These swarms merely fly out when disturbed in their resting places and do not breed there. The salt marsh species, usually hide in the grasses, and when disturbed fly out in large swarms. C. pipiens and restuans and some of the Anopheles seek shelter in vines and shrubbery.

LIFE HISTORY OF MOSQUITOES.

Adult females of most species may live for weeks and months; but males usually live for a comparatively short time. Both sexes hibernate during the winter months and appear early in the spring to begin their broods with the onset of warm weather. The females may bite a number of times.

All mosquitoes pass through four stages in their development. These are egg, larva, pupa, adult.

The *adult* is the form with which we are most familiar. The other stages demand water for their development. When the female mosquito has had her meal of blood she immediately prepares to deposit her eggs. The common Maryland mosquito, C. pipiens, deposits her eggs on the surface of a suitable body of water in boat-shaped masses, each egg being placed large end down, with the sides glued to neighboring eggs. Each boat contains 300 to 400 eggs. Various species differ in the manner of laying eggs. (See illustration, Figure 1.) The individual eggs are very small, oval, black objects, not so large as a fly speck. In the case of Culex they are stuck together side by side in little flat masses. The eggs of Anopheles are only slightly adherent end to end. The eggs of both Culex and Anopheles are longer than broad and rather oval in outline. In about twenty-four hours, under favorable conditions, the egg hatches and

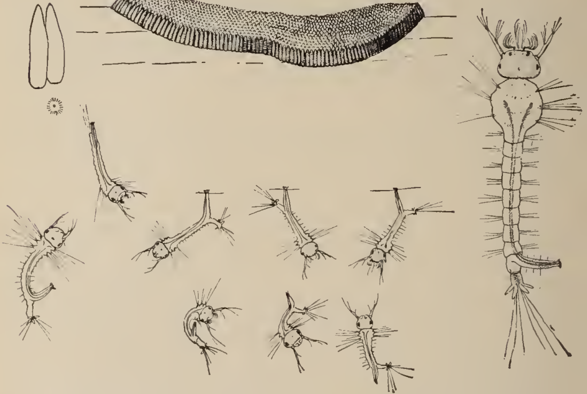

Figure 1—Culex pungens. Egg mass with a large egg at left and young larvæ below; enlarged. (After Howard, Bureau of Ento., U. S. Dept. of Agri.)

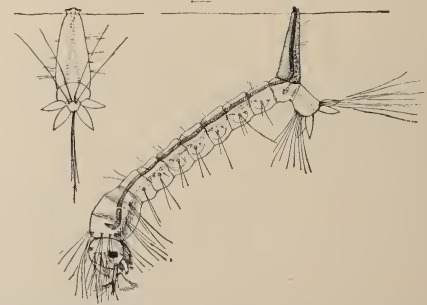

Figure 2—Culex larva in breathing position; greatly enlarged. (After Howard, Bulletin 25, Bureau of Entomology, U. S. Department of Agriculture).

the *larva* emerges from the lower end, through a sort of trap door, which opens for its exit.

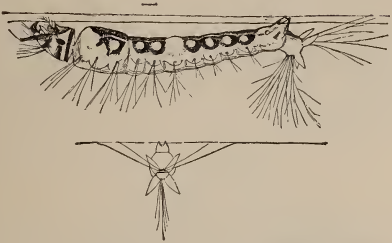

Figure 3—Anopheles larva in feeding position. (After Howard, Bulletin 25, Bureau of Entomology, U. S. Depart. of Agri.)

The larval stage of the mosquito is a very active one. As soon as the larva emerges it begins to wriggle about. By means of the mouth brushes it sweeps microscopical plants and animals into its mouth opening, for it is a voracious feeder. (Figures 2 and 3.) This form of the mosquito can be found in nearly every old rain barrel during the summer, and if removed to a tumbler with some of the mud from the bottom of the pool, they can be watched through their various stages of growth. The larva casts its skin from four to six times during its growth, and at the end of a few days has increased to four or five times its original size. Now a new transformation takes place, and the mosquito has reached its third stage of growth, the *pupa*. It now becomes quiet and does not feed and is changed in its appearance. (See Figures 4 and 5.) It becomes hump-backed and

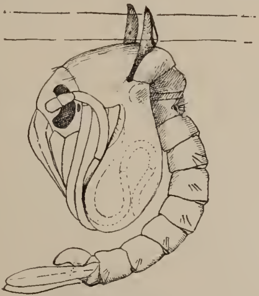

Figure 4—Pupa of Culex at surface. (After Howard, Bulletin 25, Bureau of Ento., U. S. Depart. of Agri.)

rather comma-shaped and rests at the surface of the water for hours, unless disturbed, when it darts violently away.

In two or three days the pupa begins to change. It becomes more quiescent and soon a split occurs longitudinally down its back, and the *adult* mosquito emerges from the pupa shell. The egg, larval and pupal stages of various species show differences in form and minute anatomical characteristics, which enable one to recognize the species even in these early stages.

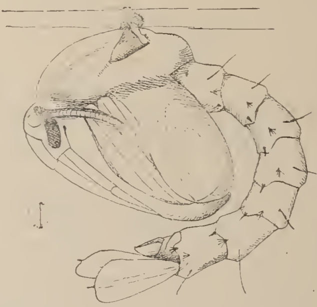

Figure 5—Pupa of Anopheles at surface; greatly enlarged. (After Howard, Bureau of Ento., U. S. Depart. of Agri.)

Mosquitoes usually pass the winter in the adult stage, but may hibernate in the egg or larvæ stage. Most Anopheles hibernate as adults, as do Culex pipiens, restuans and salinarius (described later). The eggs may be placed in the mud of empty pools, or on the bottom of pools already filled, ready to hatch when the conditions become favorable. Hibernating adults seek shelter which protect them from the cold winds and direct influence of the weather, hence they may be found in hollow trees and logs, sheltered holes, among the roots of trees, in cellars or stables or protected corners about the house. The Anopheles adult lies flat against some dark surface, legs usually spread wide apart. Only the females of this genus hibernate, and they are always fertilized before beginning hibernation. They are very sluggish and do not feed unless the temperature is raised. If kept at low moist temperature they do not feed for weeks but when roused by a rise in temperature they feed readily and the ovaries develop. Hibernating females die, in most cases, after laying their eggs. Frost does not destroy the eggs.

DESCRIPTIONS OF SPECIES.

During the summer of 1905 twenty-two distinct species were found in Maryland. Other species have been found from time to time, which will be included in the list published in this bulletin. The work done in New Jersey and New York shows certain species which, from their general distribution, may be expected to occur in Maryland. Mention will be made of these. Future investigations will, no doubt show at least fifty species in the State. The descriptions of the various species have been taken largely from the excellent report of Dr. John B. Smith, on *The Mosquitoes of New Jersey.*

THE MALARIAL MOSQUITOES.

Four species of Anopheles may be found in this State. Anopheles punctipennis is found very frequently, while Anopheles maculipennis, the real malaria carrier, is found occasionally. Both these species are quiescent during the day and fly at night. Another species, however, Anopheles crucians, is a day flyer. Anopheles barberi is a rare species, described first from Maryland.

Investigations thus far have proven only Anopheles maculipennis to be concerned in the spread and transmission of malaria; but it is not yet absolutely certain that other species of Anopheles do not transmit this disease.

The early stages of the various species of the genus Anopheles are almost identical. The eggs of this genus show quite characteristic markings, usually being laid singly and never in boat-shaped masses as the Culex. They float on the side, fifty to seventy being an average number laid at one time. When first laid by the female, they are slightly adherent, but one usually finds them separated, three, six or ten being found together occasionally. The eggs are elliptical in shape, with the ends pointed, and under the microscope they are seen to be quite prettily marked and sculptured, the upper end being almost covered by a clasping membrane.

The eggs hatch in about thirty-six to forty-eight hours and the larvæ, which differ markedly from the Culex larvæ, emerge. They are easily recognized, even with the naked eye, by their position in the water and by their markings. They lie flat on the surface, since the anal breathing tube is very short. (See Figure 3.) The body is marked with white and yellow dots and bands, the head being smaller than that of most species of Culex. The habit of surface feeding enables larvæ of this genus to live in very shallow water. The black body, marked with white spots, which becomes greenish under certain conditions, makes this larva quite difficult to distinguish, because these markings correspond so closely to the color of the leaves and grass near which they are generally found resting. One can hardly distinguish a larva from a small twig or green plant stem, so perfect is the color adaptation.

This larva feeds upon floating vegetation and often it is found just above a floating leaf or grass stem, so that even if fish were introduced into such a place to destroy larvæ many would escape destruction by hiding above these objects. This habit of surface feeding is quite characteristic of Anopheles, since the larvæ of Culex feed at the bottom of the pool, coming to the surface only for air.

The head of the Anopheles larva is unusually movable and the larvae are often seen with the head rotated through an angle of 180 degrees so that the mouth parts are on a plane with the back instead of the abdomen. Larval life is only about ten days in length in the summer. The pupa resembles that of Culex, but the back is more sharply curved. (See figure 5.) The method of emergence of the adult from the pupa shell is practically identical with that of Culex, a longitudinal split occurring down the dorsum, after a period of pupal quiescence. Through this split the adult emerges. The adults of the various species are differently marked and the description of each follows.

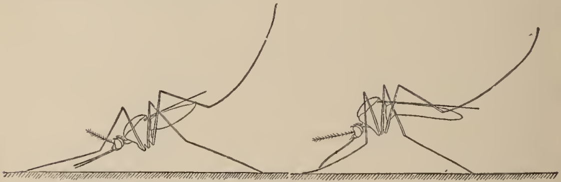

Figure 6—Resting position of Anophles and Culex. Anopheles at the left. Culex at right; enlarged. (After Howard, Bulletin 25, Bureau of Ent. Depart. of Agri).

Anopheles species are almost as abundant as Culex. In fact we found them breeding often in the same pools and in almost as great numbers. Anopheles punctipennis is probably more abundant than the other species, but the real malaria carrier, Anopheles maculipennis is found breeding everywhere, in tin cans, buckets, troughs, etc., and is almost as much a house mosquito as some of the common species of Culex. The larvae are said usually to prefer grassy pools of clear, clean water; but this is not always the case, for they may be found in foul water, and are very commonly found in a temporary pool of rain water, usually near a dwelling.

Anopheles Punctipennis, Say.

The Mottled Winged Mosquito.

This is a medium-sized, dark-brown mosquito, with the upper surface of the thorax dark brown at the sides, and with several narrow lines of yellowish-gray hair, appearing as one broad, gray stripe in the center. The beak and legs are unbanded and the wings are densely clothed with black and yellow scales, two large black patches and two similar ones on the front margin being especially conspicuous.

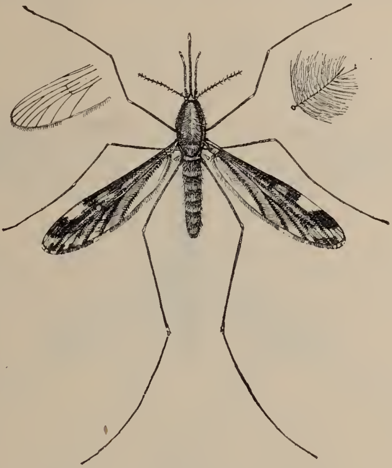

Figure 7—Adult Anopheles punctipennis.

The abdomen is dark brown, covered profusely with yellow brown hairs. (See figure 7.)

Anopheles Crucians, Say.

The daylight Anopheles.

This is smaller than the preceding species, though some are nearly as large as punctipennis. It is brown, not quite as dark as punctipennis, the thorax being striped with greyish scales, the wing veins clothed with whitish and blackish scales, the latter especially along the wing margin. (See Figure 8.)

Anopheles Maculipennis, Meig.

The Four-Spotted Anopheles.

This is similar to A. punctipennis, but much lighter brown in color, and, consequently, the thoracic stripe, which is also more yellowish, does not stand out so clearly. The wing veins are clothed with brown scales, some of which gather into four distinct patches. This distinguishes it from all other species at a glance.

DOMESTIC SPECIES.

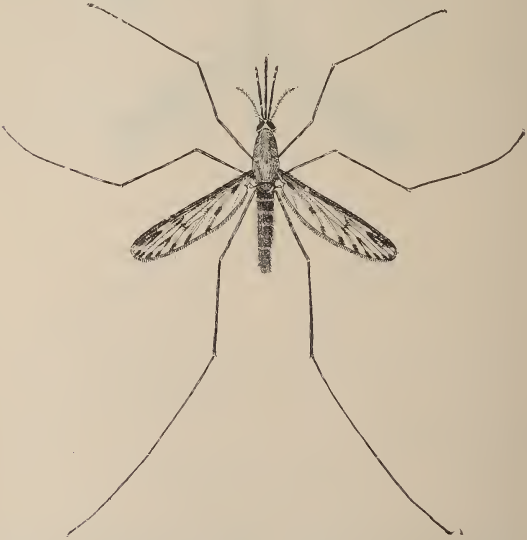

Figure 8 —Anopheles crucians; female enlarged. (After Howard, Bulletin 25, Bureau of Ento., U. S. Depart. of Agri.)

Culex Pipiens, Linn.

The House Mosquito.

This species is probably the most abundant one in the State, for it is found in towns and country districts in large numbers and is annoying as a persistent biter. The adult is a mosquito of medium

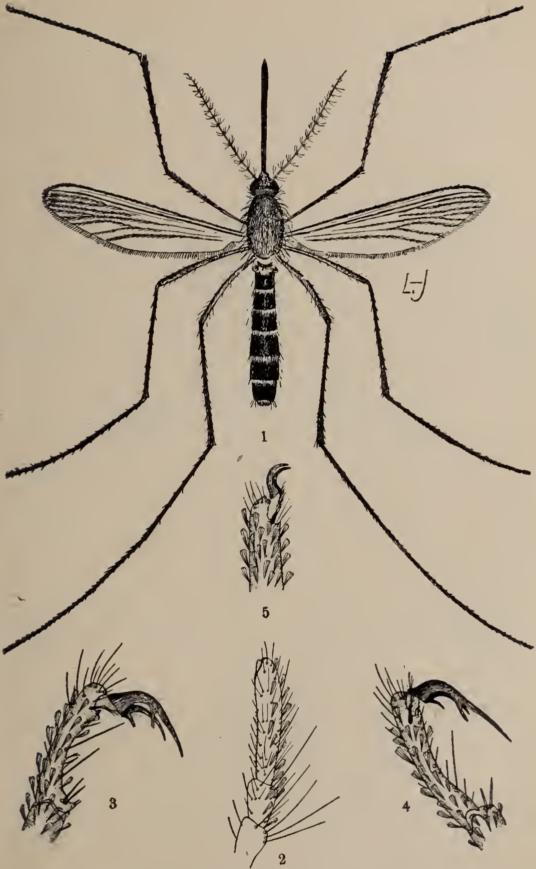

Figure 9--Culex pipiens: 1, adult female: 2, palpus; 3, anterior; 4, middle; 5, posterior claws of male; all enlarged. (After Smith, Report of Mosquitoes of New Jersey).

size, the head being brown, with a few yellow scales and a yellow border to the eyes. The beak is brown, darker towards the apex, and somewhat thicker and shorter in the male than in the female; the thorax is brown, with many golden scales scattered over the surface; the abdomen is blackish brown, with yellowish moderate or narrow bands at the base of the segments. The mosquitoes vary considerably in size and color, but are easily recognized by the fact that they have no strikingly characteristic marking. It is the common, everyday brown mosquito.

Habits and Life History.—The adult is persistent in its attempts to gain entrance indoors. Just at twilight on summer evenings it can be seen hovering against the sides of buildings and may rise to the second or third story, seeking entrance through crevices in screens or doors. It hibernates in the adult stage in any sheltered place about human habitations. Cellars, attics, stables, outhouses or closets may furnish it winter quarters. Hibernation begins early in the autumn, before breeding ends. It is said by some that only the impregnated female hibernates, but I have seen great numbers of males of this species in the early spring, before any breeding had occurred, apparently recovering from their long winter sleep.

Culex pipiens is not a migratory form and flies no further than is necessary to secure food or to find a suitable place to oviposit. Smith says that blood is not necessary for this species for the development of the ovaries.

In the spring, when warm weather has come, the hibernating females awaken, seek food and deposit their eggs. The female oviposits in early morning or at night in any suitable body of water. The eggs of this species are laid in egg boats or rafts, each containing 300 to 400 eggs. The length of the life cycle is from 10 to 16 days in summer months.

The number of broods of Culex pipiens during the summer is indefinite and depends upon the favorableness of conditions. During warm, rainy seasons, when plenty of puddles exist, it breeds rapidly. A single rain barrel may produce hundreds of thousands of this annoying pest in a comparatively short time.

The larva is very active. The breathing tube is of moderate length and the larva hangs head down and at an angle with the surface of the water when breathing. This position is characteristic of most of the species of Culex, the Anopheles differing from them in resting flat on the surface of the water. (See Figures 2 and 3 .)

The larvæ feed upon animal and vegetable matter in the water. In a glass jar one sees them feeding in the mud and debris at the bottom. They may feed on the cast larva skins, small leaves, etc. The larvæ can be found almost anywhere, but especially in stagnant water about human habitation. Excessive foulness of water does not deter their development. Culex pipiens begins to breed in the early spring and continues its activities up to the early fall in Maryland.

It may be said to be the most troublesome and annoying species throughout the State. Culex sollicitans is more persistent in its biting and a more ferocious biter, but the species is not so widely distributed, occurring mostly about salt marsh districts.

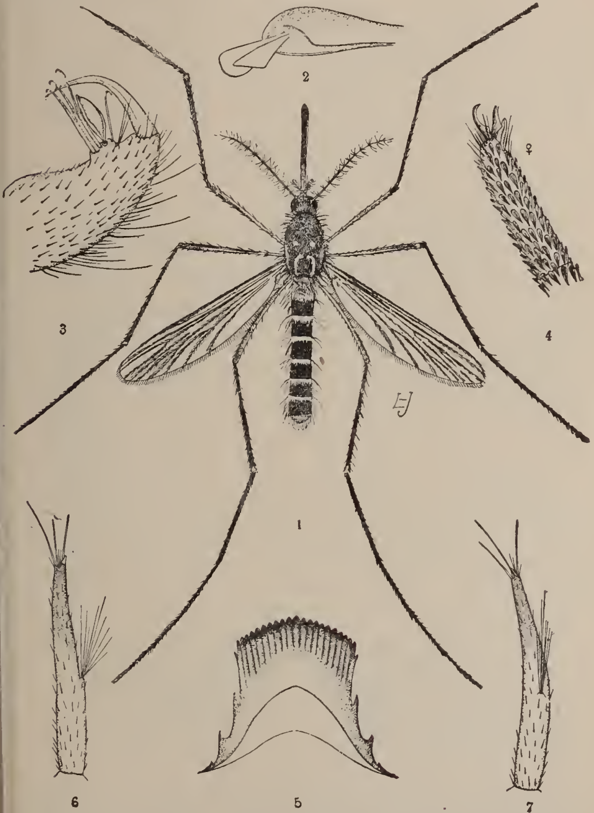

Figure 10—Culex Restuans 1, adult female; 2, appendages to tip of clasper; 3, clasper of male genitalia; 4, anterior claws of female; 5, mentum of larva; 6, 7, antennae of same; all enlarged. (After Smith, Report on Mosquitoes of New Jersey).

Culex Restuans, Theob.

The White Dotted Mosquito.

This species is so closely related to Culex pipiens in characteristics and habits that the description of one suffices for that of the other, except the markings of the thorax. (See Figure 10.) Culex restuans has two or four small white spots on the upper surface, and sometimes there is a U-shaped mark near the base of the thorax. The adult is found as abundantly as Culex pipiens and is fully as troublesome a pest.

Culex Perturbans, Walk.

The Irritating Mosquito.

This is quite a large species, with tarsi broadly banded with white at the base of the joints, and a similar band in the center of the first joint. The beak is white-banded at the center, and the abdomen shows indistinct narrow bands at the bases of the segments. The early stages of this species are unknown, and, although the females have been carefuly examined, rarely have developed ovaries been found. The larvæ have been sought for in all conditions and surroundings, but to no avail. The female is a fierce biter and becomes a domestic pest from its untiring efforts to gain entrance indoors. Nothing is known concerning its hibernation.

SALT-MARSH MOSQUITOES.

These species are of greatest economic importance along the sea coast, although some are often found considerable distances inland. They are usually found where low-lying areas become water covered during high tides and marsh lands result. Such places give admirable opportunities for breeding. Maryland, with its rather extensive coast line, produces five species. In the order of their importance they are as follows:

1. Culex sollicitans. The White Banded Salt Marsh Mosquito.
2. Culex cantator. The Brown Salt Marsh Mosquito.
3. Culex jamaicensis. The Spotted Salt Marsh Mosquito.
4. Culex salinarius. The Unbanded Salt Marsh Mosquito.
5. Culex tæniorhynchus. The small Salt Marsh Mosquito.

Culex Sollicitans, Walk.

The White-Banded Salt-Marsh Mosquito.

The distinctive characteristics of this mosquito are the broadly white tarsi, the white-banded beak and the yellowish white transverse

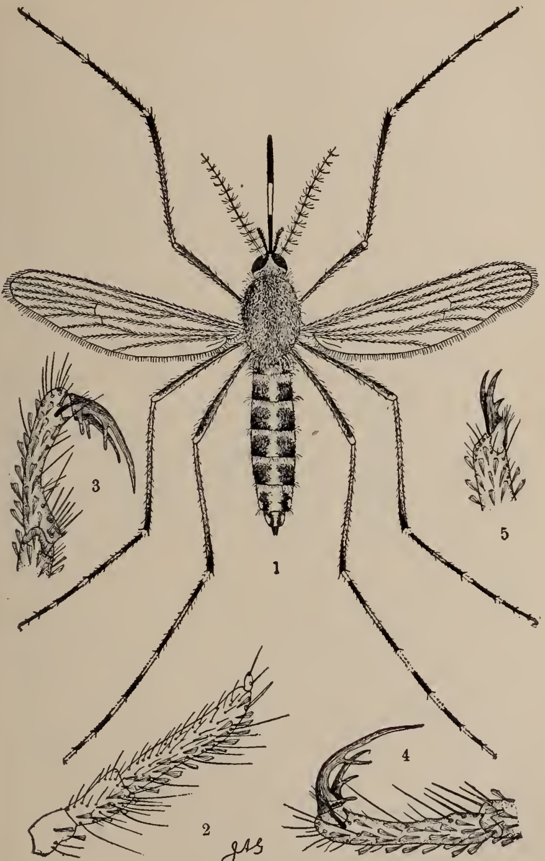

Figure 11—Culex Sollicitans: 1, adult; 2, the palpus; 3, anterior; 4, middle; 5, posterior claws of male; much enlarged. (After Smith, Report on Mosquitoes of New Jersey).

bands at the base of the abdominal segments, crossed longitudinally in the center by a broad continuous line of the same color. The thorax is golden brown, with the sides silvery white. These markings are found on no other species and make C. sollicitans easily recognized. (Figure 11.) It is a medium-sized or rather large mosquito of a beautiful color.

Habits of the Adult.—This is the most common mosquito in New Jersey in ordinary seasons, and is of great economic importance on account of holding down property values along the sea shores. In Maryland it is equally troublesome as a summer pest.

This mosquito is probably the greatest pest in the entire mosquito family. Records are not wanting of men being driven almost frantic by them. They bite under any circumstances, sunlight or strong winds having no influence upon them. Usually the adults hide in the grass or in the foliage of low bushes, and, on the slightest disturbance, fly out in great swarms. If the wind is blowing too hard for the mosquito to fly against it, it will crawl up the legs of the victim. It does not make any great effort to get in doors.

Most of the stories regarding mosquito migration are traceable to C. sollicitans, for many of the female adults leave the marshes soon after hatching and fly great distances inland.

Egg-Laying Habits.—Dr. Smith has demonstrated that this species deposits its eggs in marsh mud and that the eggs are rarely laid in water, as is the case with most other species. The eggs may survive an almost complete drying for a remarkably long time and hatch promptly as soon as they become water covered. This illustrates again the remarkable means which nature provides for the preservation of species.

Egg laying may begin within a week after the development into the adult. Permanent bodies of water do not serve as breeding places, but rather the temporary pools produced by rains or tides, which leave damp holes of marsh mud upon evaporating. The eggs must be dry, or at least not water covered for at least 24 hours after they are laid; otherwise they will not hatch. They may remain dry for three months or longer without losing their vitality.

Slow drainage is a positive advantage in the control of this species, as the eggs hatch when covered with water from high tide or a rainfall, and the larvæ are killed before they reach maturity by the drying up of the pool. Only a portion of the eggs in a single batch hatch out when water covered, and the rest remain until a later period. For example, if 200 eggs are supposed to be in a batch, 100 may hatch at the first covering by water, if the eggs have previously been uncovered for twenty-four hours. Of the remainder fifty would probably hatch at the second covering, and of the remaining fifty, ten would lie over till the spring following, and others would hatch if covered during the season. Assuming that the original 200 were not water covered at all during the season, probably half of them would develop in the season following.

Habits of Early Stages.—When the eggs having been dried for a period are covered with water, the larvæ develop in a very short time. They thrive in salt or fresh water, though this species is usually found near the salt marsh areas. The more abundant the food supply the more rapid the development. The food of the larvæ, as in other species, is microscopic plant and animal matter found in the pools. The length of life from egg to adult may vary, according to temperature and food supply, from one week to fifteen days. At summer temperature animal life in pools develops rapidly, so that there is plenty of food for the young larvae.

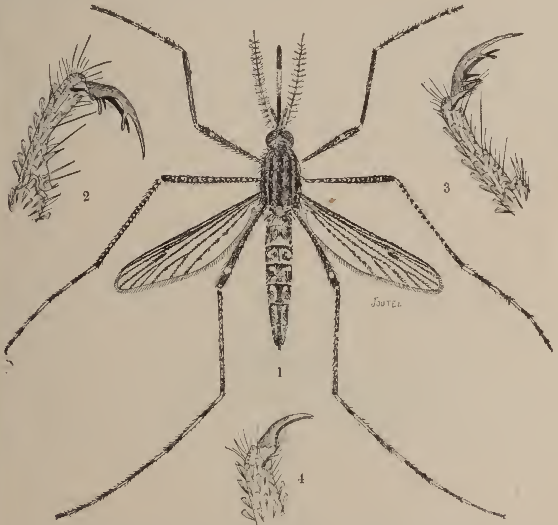

Figure 12—Culex jamaicensis: 1, female adult: 2, anterior: 3, middle: 4, posterior claws of male: all enlarged. (After Smith, Report on Mosquitoes of New Jersey.)

Culex Jamaicensis, Theob.

The Spotted-Legged Mosquito.

This one of the salt-marsh species is a dark slate colored or black mosquito of large size. Like C. sollicitans, the beak has a white band near its center. The wings are thickly clothed with black and white scales, giving them a dotted appearance under a lens. The thorax is black and has a more or less striped appearance, as shown in Fig. 12. The femoræ are black, with scattered yellow scales. The apex is white and there is a broad white band near the apex of the posterior femoræ, a narrow band on the anterior and almost none on the median pair. Tibiæ are black, with a white dot at the base and many white scales collected into spots at one side. The tarsi are black, with broad white rings at the base of all joints, except the fifth, on the fore and mid feet; the fifth tarsal joint has also a broad white band at the center, less distinct on the mid and anterior pairs. The abdomen is jet black, the first segment with a patch of yellowish white scales in the center of the apical margin and the segments from the third with two C-shaped marks back to back.

Habits of the Adult.—This mosquito was frequently found during our collecting. It probably does not fly far and is a local pest. The species probably winters in the egg state and is not an early mosquito. The larvæ sometimes assumes positions similar to the Anopheles. They are usually found in transient pools. It seems possible that this species deposits its eggs in the mud of pools, from which the water has evaporated.

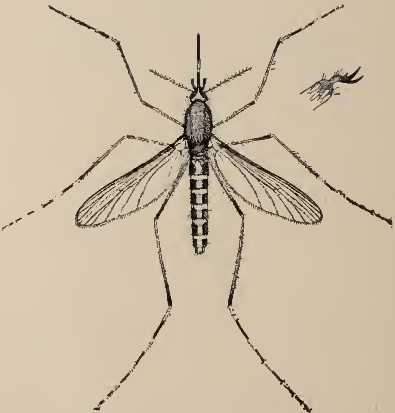

Figure 13—Adult Culex taenioryncnus.

Culex Tæniorynchus, Wied.

The Small Salt-Marsh Mosquito.

This is a small, black mosquito, with narrow white bands at the base of the abdominal segments. The beak has a narrow white ring at its middle, and the legs are banded with moderate bands of white at the tarsal joints, the last joint of the hind feet being entirely white. This species is quite similar to C. sollicitans, but there is no longitudinal abdominal stripe. The head is dark brown, with a few yellowish scales, which sometimes make a diffused patch in the angle formed by the eyes. The thorax is brown, darker laterally, with some yellowish scales over the surface. The femoræ are black above, pale yellowish beneath, with a very few yellowish scales. The tibiæ are black, spotted with yellow scales, and may be black or yellowish beneath. The tarsi are black and white, ringed at the base of the first three joints. The abdomen is black, each segment having a narrow basal band of white crossing the segment. (See figure 13.)

Habits.—This species is quite similar to Sollicitans, but not so abundant.

Culex Salinarius, Coq.

The Unbanded Salt-Marsh Mosquito.

This species is very similar to C. pipiens and in all the structural details, save the tip of the female palpi the drawings of one serve for illustrations of the other. C. salinarius is slightly smaller, giving the legs an appearance of unusual length and somewhat darker color than C. pipiens. This one of the salt marsh species does not migrate far from its breeding place, and is the only one that hibernates in the adult state. It is a night flyer, never venturing out in broad daylight, like sollicitans; but in the evenings it is very bloodthirsty. Egg boats are found, as in the case of C. pipiens, but containing fewer eggs and the boats disintegrate readily. The larvæ are found in salt and fresh water.

Culex Cantator, Coq.

The Brown Salt-Marsh Mosquito.

This is rather a large brown mosquito, in which the thorax is pretty well covered with distinct spiny hairs. The beak of this species is not banded; the wings are not spotted; the tarsi are banded with white at the base of each joint, the bands not always being well marked and merging gradually into the brown color of the legs; the abdomen banded rather indefinitely and the bands are not constricted at the center. The head is yellowish brown, the beak dark brown, almost black, with no special markings; the thorax reddish brown clothed with short, upright, golden-yellow hairs.

Habits of the Adult.—Owing to the close resemblance of this species to C. cantans and sylvestris, it was not recognized as a distinct species until 1903. It begins to breed early in the spring, and by its migrating in swarms, is one of the first to herald the approach of the mosquito nuisance. It breeds usually in such places as sollicitans, and the two species may be found quite abundantly together. Cantator may be found until late in the summer and becomes one of the pests of midsummer. Especially does this pest become a nuisance on account of its ability to make extensive migrations and flight. The male and female alike are able to migrate for considerable distances. They readily enter human habitations and are fierce biters. It is not quite so active as C. sollicitans, but is quite similar to that species because of its migration, its flight during the daytime and its breeding in such places as are frequented by C. sollicitans.

Habits of the Early Stages.—Egg laying is similar to C. sollicitans. The eggs are larger, however, and laid in greater numbers and the water may be salt, brackish or fresh. It is almost impossible to distinguish the young larvæ of C. cantator from those of C. sollicitans; but, as they become larger, the head of the former becomes marked with characteristic maculations and may, in this stage, resemble C. tæniorynchus very closely; but when fully grown the breathing tube of C. cantator is seen to be quite broad and larger than that of C. tæniorynchus.

In the warm days of midsummer this species breeds very fast, and each rainfall brings new broods with the filling of the pools. The first broods do not develop rapidly, and in April and May the numbers of this species do not become markedly abundant. C. sollicitans and cantator are the most important of the salt-marsh species and they cause the most annoyance in the vicinity of sea coasts. Salt marshes along the uplands have been observed swarming with larvæ after high tides. Here they are somewhat protected from spraying operations by thick grass, and, owing to the shallow water, are safe from the inroads of small fish, and since the tide only reaches these high points occasionally the larvæ have ample time for development. The control of the species seems at first sight a gigantic undertaking, but their breeding places are confined to limited areas, and these restrictions simplify any means towards destroying their breeding places.

WOODLAND POOL AND SWAMP MOSQUITOES.

Culex Cantans, Meig.

The Brown Woods Mosquito.

This is a large brown mosquito, resembling C. cantator, but the bands of the legs and abdomen are broader and whiter. It is one of the largest species of Culex occurring in Maryland. The head is dark brown, with scattered creamy scales and a distinct yellowish white border to the eyes. The thorax is dark brown, covered with short upright scales, often collected together into a stripe. The legs are yellowish brown, the tarsi being blackish and with broad white bands at the base of the joints in the posterior legs. In the mid tarsi the bands are narrower and almost absent on the anterior. The abdomen is blackish brown, broadly banded at the base of the segments with creamy white, which is also sometimes found on the apex of the anterior segment. The bands become broader toward the sides, more so posteriorly, until they connect at the side, and the apical segment is often wholly white. The bands are very broad in the male, giving the appearance of black bands on a whitish abdomen.

Habits and Life History.—This is a species quite common in colder climates than Maryland, but may be found here and in New Jersey. According to Dr. Dyar, it flies most of the summer, though

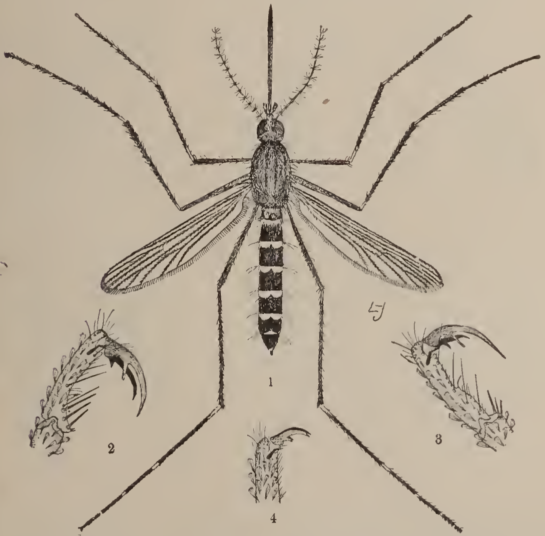

Figure 14—-Culex sylvestris: 1. adult female; 2. anterior; 3. middle; 4. posterior claws of male; all enlarged. (After Smith, Report on Mosquitoes of New Jersey.)

there is but one generation. The larvæ may survive the winter and may hatch from over wintering eggs, and for that reason the species is one of the early spring mosquitoes, resembling C. canadensis in this particular. Its development is not rapid in the early months.

The eggs are laid singly and readily sink in the water. Experiments have shown that eggs hatch as soon as the ice of the pool disappears. A peculiarity of the larva is that it is found usually in deep pools and feeds upon the leaves at the bottom, so that collecting it is not an easy task.

Culex Sylvestris, Theob.

The Swamp Mosquito.

This species is quite widely distributed in the State and is found with nearly every collection from woodland or pasture pools. It is most abundant after midsummer.

It is a medium or small sized mosquito, with the tarsi narrow, white ringed at the base of the joints, the beak being unbanded and the rings unspotted. The abdominal segments have bands of pure white at the base, constricted in the center and narrowed at the sides. (Figure 14).

Habits and Life History.—C. sylvestris is not a local pest and may be found often at a considerable distance from its breeding place. Dr. Smith says that in New Jersey it is found from one to five miles from its breeding grounds and does not move in swarms, but rather individually. The eggs are deposited singly on the water's surface and readily sink to the bottom, or they may be deposited at the edge of a pool or in moist mud, from which the water has evaporated. Larvæ of this species are not found in foul or brackish water, but are most common in woodland pools and swamp areas. In districts not far from Baltimore these larvæ were found in millions where the grassy edges of pools had become submerged after a heavy rainfall. The eggs do not hatch evenly in the spring, for pupæ and very young larvæ may be found at the same time. Some eggs may lie over until the next season, or until later in the same season. They are abundant during the entire summer and are quite easily controlled by such methods as are employed for C. sollicitans in salt-marsh districts.

Culex Canadensis, Theob.

The Woodland Pool Mosquito.

This is the first species of early spring in Maryland, and is of interest, because of the extreme cold which it may withstand. It is quite a large mosquito and its distinctive characters are the white-banded tarsi, the last joints of the hind feet being entirely white and the other joints being white at both base and tip. It has a black un-

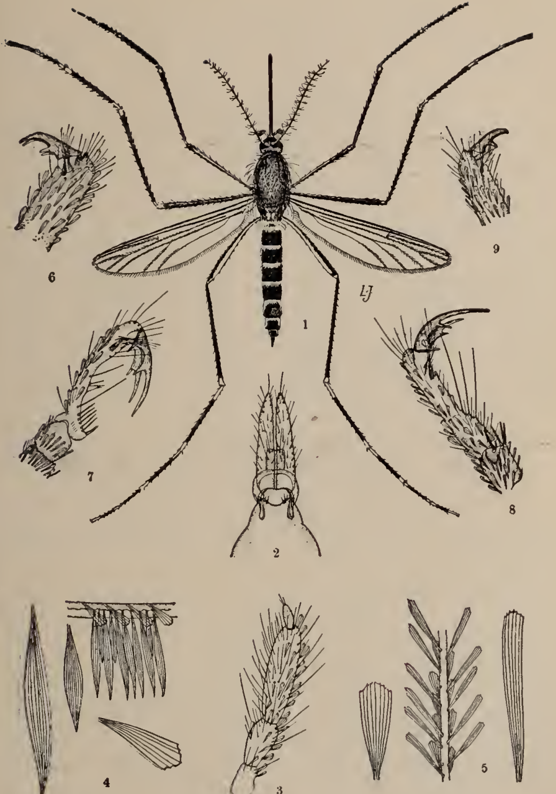

Figure 15—Culex Canadensis: 1, female adult; 2, the ovipositor; 3, the palpus; 4, margin of wing showing fringed scales; 5, part of vein showing scale; 6, anterior claws of female; 7, anterior; 8, middle; 9, posterior claws of male; all much enlarged. (After Smith, Report on Mosquitoes of New Jersey.)

banded beak, unbanded thorax and unspotted wing. The thorax is brown, with no characteristic markings. The abdomen is blackish, with narrow white bands at the bases of the segments, the sides becoming more broadly white; beneath it is white, with broad black bands. (Figure 15).

Habits and Life History.—This mosquito has been found in the spring before any other species are astir. Here it was found early in April and the larvæ were almost fully grown, and since the growth is slow in low temperatures it is quite possible that these specimens may have existed as larvæ five or six weeks. The species shows a remarkable vitality in low temperature. While in the larval stage it may be frozen in blocks of ice without harm; but usually seeks protection in the bottom mud. It is usually to be found in woodland pools, in which are fallen leaves, and, owing to this dark background, the larvæ are not readily seen. They are usually found in clear, clean water, and, early in April, we have seen them in countless numbers. They are not very active so early in the spring, and when disturbed wriggle lazily out of harm's way. When the warm days of early spring come the broods develop quite rapidly. The bite of the species is quite painful, and the female readily attacks her victim. It is essentially a wood mosquito and does not fly so readily by day as in the early morning or at dusk. Migration is not extensive and the mosquito does not seek human habitation.

Janthinosoma Musica, Say.

The Big Woods Mosquito.

This species is easily recognized by the densely scaled legs, the metallic purple thorax and abdomen and the snowy white hind feet. (Figure 16.) It is not rare in Maryland, though we did not find it in the larva state.

Habits and Life History.—This is one of the most persistent and painful biters found in this latitude. So intent is it in its attempts to find blood that they are easily captured with glass vials or catching-bottle. This is a species of southern range in general, although it has been found occasionally in northern localities. Dr. Dupree, of Louisiana, thinks the eggs, which are deposited singly, normally rest upon floating debris. The eggs resemble those of Stegomyia fasciata, having a flat and concave surface. They sink to the bottom of the pool soon after oviposition. The larvæ are active at the surface for the first twenty-four hours, when they move to the bottom if disturbed, and may remain submerged for some time. The larvæ are not strictly wrigglers, for they jerk characteristically when suddenly disturbed, but ordinarily move in the water at an angle of forty-five degrees, with little motion save the rapid movement of the anal cilia. This species is not a domestic one and is rarely found in numbers away from the woodlands.

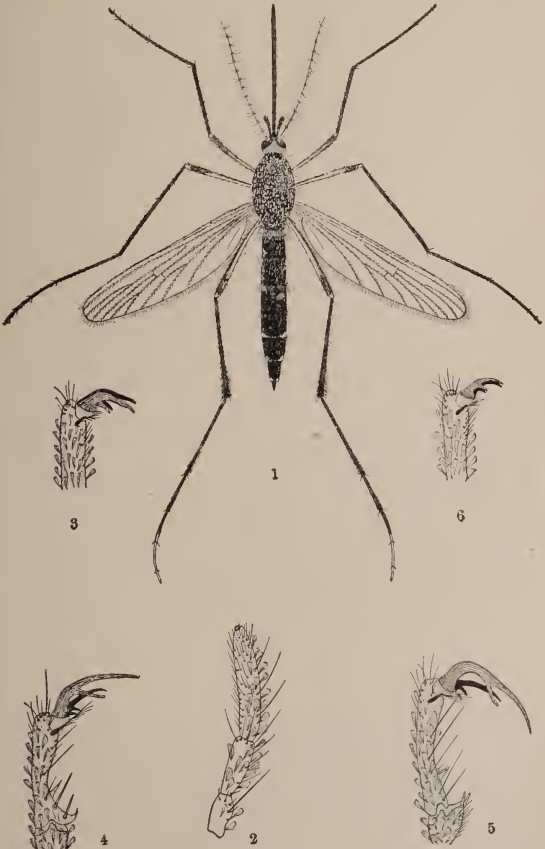

Figure 16—Janthinosoma musica: 1. adult female; 2. the palpus; 3, anterior claw of female; 4, same of male; 5, middle, and 6, posterior claw of male; all enlarged. (After Smith, Report on Mosquitoes of New Jersey).

Megarrhinus Rutila, Coq.

The Curved Beak Mosquito.

This is a large species, the characteristic curved beak and large size sufficing for its identification. The larva is large, comparing in this regard to Psorophora. The species is found occasionally in this State, but is not common.

Tæniorynchus Squamiger, Coq.

The Scaly-Winged Mosquito.

This species was encountered in the adult form, usually in woodland districts. Further investigation will, no doubt, show its breeding places. It is quite a painful biter.

MISCELLANEOUS SPECIES.

Culex Discolor, Coq.

The Mottled Mosquito.

This mosquito is a rare species. It is yellowish brown, of rather small size, with the legs and beak banded. The abdomen is brown and yellowish white and the wings are spotted. These markings distinguish it from all other species. The adult has not been taken and little is known of its habits. The larvæ attract attention because of the long white antennae and by their habit of lying on the back at the bottom of the pool. They remain below the surface for a considerable time. The species is not to be considered a pest, but mention is made of it because of its occasional occurrence.

Culex Atropalpus, Coq.

The Rock Pool Mosquito.

This species is to be found breeding in pot holes and depressions in rocks where water collects and provides breeding places more or less permanent. It is closely allied to C. candensis, the tarsi being ringed with white on both sides of the joint, except in the last two joints of the hind feet and the last three of the fore and mid feet. The last joint of the hind pair are wholly white. The beak is unbanded, the wings unspotted and the thorax is golden yellow, with a blackish central stripe, the segments of the abdomen having narrow irregular white bands at their bases.

Habits and Life History.—The eggs are deposited in the fall in patches on the side of rock pot holes, when the water is low. They begin to hatch irregularly in March, and the larvæ grow slowly. The eggs are black, elliptical, coarsely reticulated, the ends roundly pointed. The larvæ are rather deliberate in their motion and remain long below the water's surface, and when they thrust out their breathing tube for air, do not long remain in that position.

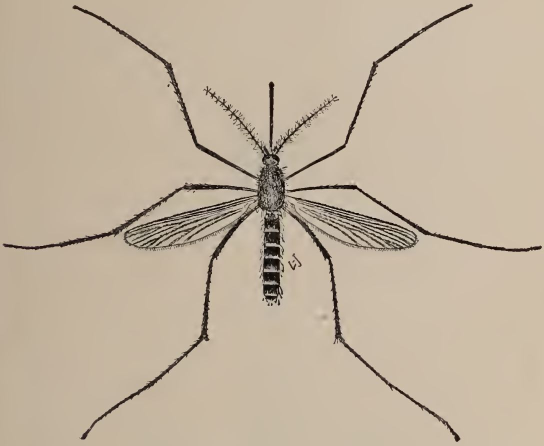

Figure 17—Culex territans: adult female; enlarged. (After Smith, Report on Mosquitoes of New Jersey).

Culex Territans, Walker.

The Little Black Mosquito.

Culex territans is a small, black mosquito, with long unbanded legs and beak and unspotted wings. The abdomen is narrowly banded with white at the apex of the segments. In this particular it resembles Culex discolor, but that species differs in having spotted wings. The thorax is brown, with no spines, though the sides are fringed with long, black, curved hairs. The pleurae are brown, with patches of grayish white scales. The femoræ and tibiæ are very dark brown, their apices with a white spot and the under side creamy white. (Figure 17.) The tarsi are all black, without rings or bands.

Habits of the Adult.—Dr. Smith states that little is known of the habits of this species. It is found not infrequently in Maryland, the larvæ being found in considerable numbers with those of Culex pipiens or with Anopheles. We found this species breeding in rain barrels with Culex pipiens and restuans; in roadside pools with Anopheles punctipennis; in rock pools with Culex atropalpus; in pools in quarries and marshes with Culex salinarius. In fact, this species was found with nearly every collection of larvæ, especially in June and July. There has been some question as to whether the species bite. Our observations show that it does to some extent, though not so freely as Culex pipiens. It is not known definitely how this species hibernates, but it is probable that it passes the winter in the egg state. So far, none of the species have been found in collecting hibernating adults.

The larva is easily recognized from the fact that the head is large and square and the anal siphon tube is long and slender. The adult is not a really troublesome insect, which is fortunate, for its breeding places are usually such as are not easy to control.

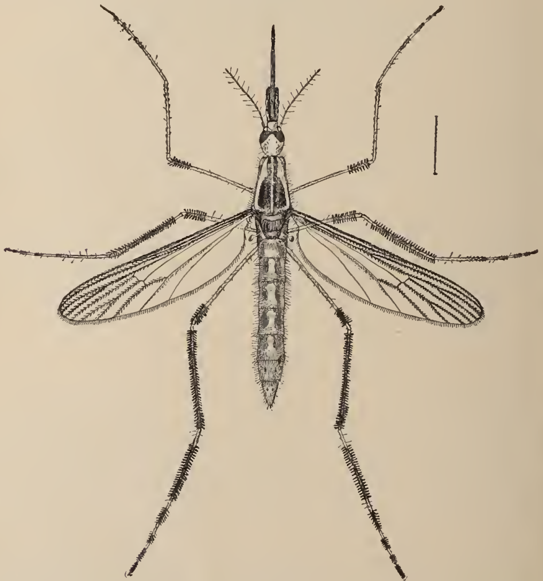

Figure 18—Psorophora ciliata; female adult; enlarged. (After Howard, Bulletin 25, Bureau of Entomology, U. S. Department of Agriculture).

Psorophora Ciliata, Fabr.

The Giant Mosquito.

This mosquito is really of enormous size, being the largest mosquito known. Though said to be a rare species, it is found quite commonly in Maryland during the hot season of midsummer. It is a ferocious biter and the bite is very painful. The species is easily recognized on account of its large size and the peculiar legs, which are thickly covered with erect black scales. There is a median band of golden yellow scales on the prothorax. The head is covered with mixed brown and white scales, the brown ones being collected into three stripes, which extend from the base of the head to the posterior margin of the eyes. The proboscis is black and unbanded.

Habits of the Adult.—Clothing is of little protection against this species, and its large size and persistency in attempting to bite may well strike terror into its victim. Our observations showed that these mosquitoes do not fly in swarms, but come suddenly upon the victim like a bolt from a clear sky. Bright sunlight does not deter it from its bloodthirsty purpose and all attempts to brush it away are fruitless, as it will simply seek a new spot and become absorbed in its attempt to bite. One can quite easily catch them on the clothing with the killing bottle. The males are not encountered flying. It is not a domestic species and is most troublesome in the open fields or near a woods or thicket. It seems to prefer horses and cattle as hosts, and pastures become almost useless for these animals when Psorophora is present in any considerable numbers. It is even more persistent and ferocious than C. sollicitans in our experience.

The habits of hibernation are not definitely known, but it seems probable from investigations so far that it is in the egg state that this species lives through the winter.

The eggs of this species are laid at the edge of a pool or in a moist depression, where they remain until water-covered, hatching within a few hours after this event. It seems probable that blood is essential for ovarian development. The larvæ are of immense size, as wrigglers go, and, unlike other species, are predaceous, feeding upon each other and larvæ of other species. Their appetite is enormous and small larvae are swallowed whole. The larger larvæ are seized just below the anal siphon, or breathing tube. There is no greater foe to mosquito larvæ than Psorophora, and its rank as a pest usually does not overbalance the benefit derived from it. Unfortunately, its predaceous habits limit its own numbers.

The following species occur in neighboring States and under conditions similar to those found in this State, and further investigation will, no doubt, show them to occur here. Accounts of these species may be found in the original descriptions.

Culex trivittatus, Coq.
Culex triseriatus, Say.
Culex squamiger, Coq.
Culex niveitarsis, Coq.
Culex siphonalis, Grossb.
Culex signifer, Coq.
Culex serratus, Theob.
Culex dupreei, Coq.
Culex pretans, Grossb.
Culex inconspicuous, Grossb.
Culex aurifer, Coq.
Culex confinis, Arrib.
Culex bimaculatus, Coq.
Culex impiger, Walk.
Anopheles barberi, Coq.
Aedes fuscus, O. S.
Wyœmyia smithii, Coq.
Uranotænia sapphirina, O. S.

Dr. D. W. Coquillet, Assistant Entomologist of the Department of Agriculture, has recently published "A Classification of the Mosquitoes of North and Middle America," which entirely revises all nomenclature of species.

The new classification affecting species mentioned in this bulletin is as follows:

The generic name Ochlerotatus is to be substituted for Culex in the following species:

Pretans, impiger, confirmatus, serratus, triseriatus, aurifer, niveitarsis, tæniorynchus, sollicitans, atropalpus, canadensis, cantator, sylvestris, siphonalis, inconspicuous.

Culex discolor, confinis and jamaicensis become Grabhamia discolor, confinis and jamaicensis, respectively.

Culex perturbans becomes Isostomyia perturbans.

Culex signifer becomes Pneumaculex signifer.

Culex squamiger becomes Lepidoplatys squamiger.

Culex annulata becomes Theobaldia annulata.

Janthinosoma musica becomes Janthinosoma posticata.

Others stand as described.

MOSQUITO CONTROL.

By Arthur B. Gahan.

As already stated in the first part of this report, it is only recently that the question of mosquitoes has been studied systematically and with a view to their eradication. Formerly they were regarded as simply an unavoidable nuisance; but in the light of the present knowledge of their habits, life history and breeding places, their control is not as complex a proposition as it at first seems. Already a great deal of practical work has been done in New Jersey and several other States with surprising success towards the extermination and control of the pest.

No originality is claimed for any of the recommendations made herein, as they are, for the most part, compilations of the work of other investigators, particularly those of Prof. John B. Smith, of New Jersey. Lack of funds available for such work have made it impossible to undertake experiments here, except on a limited scale.

Three reasons may be cited why the work is of prime importance to the public of Maryland, viz.: (1) The public health requires it. (2)The public comfort demands it. (3) Large tracts of land that are now almost uninhabitable may be rendered available for development. Any one of these should be sufficient to arouse the interest of every public-spirited citizen.

Dr. Coffin has discussed the first of these reasons at some length in his report, showing that it is an established fact that certain species of mosquitoes are the only source of transmission of malarial diseases and yellow fever. The second needs no discussion, since it is apparent to everyone that at least throughout a large portion of the State the public comfort would be greatly increased were the mosquitoes eradicated.

As for the third, only those who have visited one of these mosquito-cursed localities can appreciate the force of the argument. Much of the area of the eastern portion of Maryland is so low as to afford but imperfect drainage, and, as the average rainfall is high, abundant swamp areas and stagnant pools furnish ideal breeding places for all kinds of mosquitoes. Also long stretches along the bay shore and the Atlantic coast are subject to overflow by high tides, creating many salt marshes. Conseqently, we find extensive localities whose development is greatly hindered, if not entirely prevented, by the fact that millions of these insects breed in the stagnating pools of the marshes and swamps. Even in the vicinity of Baltimore there are several districts of greater or less extent that are now practically worthless, which could be turned into valuable properties by getting rid of the mosquitoes. One of these districts is said to furnish a large per cent. of the malarial cases in the city hospitals.

If, then, it is true that the public health will be benefited, the comfort of the inhabitants increased and property values raised by mosquito control, it remains to be seen whether the work can really be done successfully. Can they be kept down to such an extent that malarial fever and yellow fever will be done away with, freedom from annoyance from their bites secured and land values raised in infested districts? That all three objects may be attained by careful work has been demonstrated in several instances, notably in Cuba, where yellow fever has been practically eliminated by the work of the United States Army Medical Hospital Service; in New Orleans, where the recent outbreak of the same disease was stamped out by a war on the mosquitoes, and in New Jersey, where, under the direction of Professor Smith, several badly infested localities have been practically rid of mosquitoes and rendered valuable residence districts.

Before going into the matter of treatment it will be necessary to understand perfectly the breeding habits of the species. This has been treated by Dr. Coffin in the detailed account of the species; but it may be well to briefly emphasize the facts here.

In the first place, it should be definitely understood that all species so far as known require water for their development. The eggs are deposited on or near the water and the larval and pupal stages passed in it. In every case, with possibly a very few exceptions, the water must be stagnant, possibly because the larvæ live upon small aquatic plant life, which cannot be found in running water. Both salt and fresh water forms occur. A very small quantity of water will serve to breed a great number of the pests in a short time. Every species has its own favored type of breeding place, to which it confines itself, though it is not uncommon to find two or three species breeding in the same pool. The larva stage lasts from one to three weeks, depending upon the weather and the amount of food obtainable. The adults hide in some dark place during the day and fly about in the evening and early morning. Hibernation takes place usually in the adult form, the females hiding in outhouses, cellars or any dark, protected place.

COMBATTING ADULTS.

Since the adults are never confined to any one place, but distribute immediately upon emergence over the surrounding community, there is very little possibility of doing anything along the line of extermination while in that form. Some good may be accomplished by destroying them where they are collected in houses or cellars for hibernation by fumigation; but so varied and numerous are the possible hiding places that we can only hope to slightly reduce the number by this means. The only measures practical after their emergence from the pupæ are purely protective ones. Careful screening of doors and windows with wire screens or mosquito netting will keep them out of the house. A screen a trifle finer than the ordinary fly screen should be used, if possible, although very few will find their way through the ordinary screen. Even where screens are used some mosquitoes will often manage to stray into the house through opening doors. Dr. Felt is authority for the statement that in such a case relief may be found by burning pyrethum powder in the room. The fumes from the powder will so stupefy the mosquitoes that they will remain inactive for twenty-four hours. Another remedy is suggested by Dr. Howard, which is a modification of one used for the common house fly. A cup or tin lid, partly filled with kerosene, is fastened to the end of a stick and shoved up under the insect, which will generally be found hanging from the ceiling in a dark corner of the room. In attempting to get away it will fall into the oil and be killed. The writer has found Prof. Smith's suggestion of rubbing the face and hands with oil of citronella before retiring to be effective. The odor of the oil is so distasteful to the insect, though not unpleasant to the sense of smell of most human beings, that they will not come near it. Several other oils may be used for the same purpose, but none are so effective. Various insect powders are also claimed to be useful in ridding rooms of mosquitoes and flies, and doubtless some of these may prove efficient.

Where it is desired to sit out of doors of an evening, the old-fashioned smudge is the only means of securing relief from the torment in infested regions. Probably the most satisfactory smudge for this purpose can be secured by the burning of tobacco stems or leaves, but any substance that will make a thick smoke will answer.

TREATMENT FOR LARVAE.

By far the most effective work in fighting mosquitoes can be done while they are in the larvæ stage. At this time they are congregated in comparatively limited areas that are easily found and often easily remedied. First of all, it will be necessary to know just where the larvæ may be found.

Since, as stated before, stagnant water is necessary for practically all species it follows that all pools or receptacles containing stagnating water may be looked upon with suspicion. Not all will be found to be infested however, as other conditions may be present to make the water unsuitable for the larvae. Old buckets, barrels, tin cans, tubs and eave-troughs partly filled with rain water are fertile sources of the common house mosquito (Culex pipiens) as well as the malarial bearing species (Anopheles). Open cess pools, sewers, cisterns, post holes, and small puddles also breed these species. Several unimportant species may be found breeding in pockets in rocks, holes in trees, and other like locations. The greater number of troublesome fresh water species such as Culex cantans, C. restuans, C. Sylvestris, C. territans, and Psorophora ciliata will be found in swamp pools and other places where poor drainage causes the surface water to collect and stagnate. Two of our worst species C. sollicitans and C. cantator breed only in the salt marshes. The former of these two is the most difficult to handle of all, owing to the wide breeding area and its habit of migration, it having been proven by Prof. Smith that the adults frequently fly long distances from their breeding places. The above will give some idea of the great variety of places in which the pest may breed.

In connection with the subject of breeding places it will be interesting to consider how some of them originate through the neglect of careless property holders and engineers in constructing roads, railroad beds, buildings, etc. Numerous instances may be cited in which property holders in excavating or grading for improvements have created basins where the dirt has been taken out or have dammed up natural drains thus creating ideal conditions for mosquito breeding. Often old buildings are torn down and the cellars left unfilled, or excavations for new buildings abandoned after a part of the work has been done. We have in mind one place in the City of Baltimore (shown in plate 1), where such a basin has been formed, and which was breeding mosquitoes by the thousands last summer. Plates 2 and 3 illustrate examples of carelessness in making vacant lots the dumping places for all manner of rubbish including tin cans. old buckets, broken bottles, etc., in which water may collect. Such places are a source of danger to the health as well as the comfort of a community since Anopheles and C. Pipiens are frequently found in just such environments. Railroads have been the most prolific creators of artificial breeding places. The grading of a road bed requires the movement of a large quantity of dirt and not infrequently there will be seen miles of ditches on either side of a railroad with no possible outlet. Such a case is shown in plate 4. Often also in the making of a fill, natural drains are completely closed (see plate 5), so that formerly well-drained areas are converted into swamps or ponds when a little care on the part of the constructing engineer would have avoided such a result. Many of the worst infested districts around Baltimore, where most of the investigation work was done last summer, may be attributed to just such cases of carelessness amounting in some cases almost to criminality. Numerous other examples may be cited such as abandoned and undrained stone quarries, (plates 6 and 7) road ruts, (plates 8 and 9) and poorly constructed gutters. A little care on the part of the property holders or companies and individuals engaged in making public improvements would do away with most of these.

How They May be Destroyed.—Two methods of destroying the larva and pupa and thus accomplishing the desired end of controlling mosquitoes are possible: 1st, by elimination of the breeding places; 2nd, by the use of larvicides. The former is much the more important because more lasting in its benefits. It will be considered first.

ELIMINATION OF BREEDING PLACES.

This may be accomplished by drainage of marshes, swamps, and pools, by emptying receptacles where possible, by covering those that cannot be dispensed with, and by stocking infested pools with fish.

In cases where individual homes that are located in perfectly drained positions, remote from swamps and other like breeding places, are bothered with the pests, it will generally be found upon a careful search being made that the trouble arises from some receptacle like a rain barrel or bucket, defective eave trough or possibly an open cess pool or water closet. If in a barrel or bucket it should be emptied if possible. If not practicable to empty it or if the trouble arises from a cess pool or closet, covering must be resorted to. A lid of boards or screen that fits tightly over the opening will keep the female from depositing her eggs on the water and prevent reproduction. All eave troughs should be made to drain perfectly. It not infrequently occurs in cities and towns that similar conditions exist and a single such source may be the cause of infestation of a whole neighborhood. In one of the suburbs of Baltimore a case was observed of a single house that had six open rain barrels under the eave spouts and in each were found breeding both Culex pipiens and Anopheles. Property owners should first see that their own premises offer no such conditions and then insist upon their neighbors doing the same. The hearty co-operation of all the residents of a neighborhood in looking after such breeding places about their own premises will often result in stamping out the pest entirely for that immediate vicinity.

The problem of dealing with districts in which the infestation comes from swamp areas and similar low lying places of large size is a much more complex one. Here drainage is the only means possible to give results proportionate to the cost incurred.

Salt Marshes.—Maryland has an exceedingly long coast line and much of the land along the Atlantic Ocean and Chesapeake Bay is but little above sea level. As has been already said, considerable areas are overflowed by extra high tides. The result is that numerous salt marshes are to be found. Here C. sollicitans and C. cantator breed in great numbers, and as the former is not only the most vicious biter among all the species, but the principal migratory form as well, often flying 40 or 50 miles inland in search of blood, it is very important that in as far as possble, these breeding places be eradicated. This can best be accomplished by ditching.

A ditch about 12 inches wide and 2 feet deep will drain all the surface water from an area several yards on either side of it. The drainage of marshes requires a series of such ditches at intervals of 75 to 100 feet. In case there are no natural outlets for ditches, marshes may be drained by digging ponds or basins, at least two feet deep at the lowest points thus taking advantage of the fact that these species do not breed in deep, open ponds. The dirt removed may be used to fill in smaller depressions and holes thus making the drainage more perfect. Such a pond if stocked with small fish will insure the elimination of the breeding place. The ditching may be done by hand or with a ditching machine. For making short ditches hand labor will be found cheaper. For this purpose a long, narrow spade is necessary. When large areas are to be drained necessitating the cutting of long ditches a machine will prove more economical. Prof. Smith estimates that the cost of hand ditching ought not to exceed one and three-quarter cents per running foot of ditch and machine ditching at one to one and a half cents per running foot for each foot of depth.

Swamp and Woodland Pools.—The cool and shallow swamp pools shaded by tall grass and bushes and with the surface covered with old leaves overgrown with duckweed and algae offer ideal conditions for the development of several species. C. Sylvestris is the principal species partial to such localities but both C. pipiens and the various species of Anopheles are also frequent breeders there.

Quite often the drainage of a swamp is a simple matter as such places usually have a natural outlet that has become clogged in some way, either by accumulation of drift and sediment or by having been filled up by man in the construction of roads, railroads, etc. In the case of stoppage by natural accumulations it is only necessary to reopen or possibly deepen this outlet to afford good drainage. In the case of artificial damming up of an outlet a simple culvert or tile under the obstruction will solve the difficulty. Plate 5 shows a swamp pool that could be completely and easily drained by a tile under the railroad fill. Sometimes, however, it occurs that the topography of the locality offers no natural outlet and it then becomes necessary to adopt other means. Unless it is possible to provide an outlet that will carry off the water some such treatment as that recommended for marshes of similar character will have to be resorted to. A sufficient space should be cleared in the lowest part of the swamp and a pond constructed that will hold all the surface water and this stocked with fish. Care must be taken that there are no shallows at the edges of such a pond and that no vegetation grows in it, as the fish will not get into the shallow and vegetation will also interfere with their part of the work. Frequently it will be found possible to make such a pond of deep water by damming the stream or streams which feed the swamp and providing some means of taking care of the overflow.

LARVICIDE.

Agents for destroying mosquito larvæ are of two general types. First, those which mix with the water and act as poisons to the larvæ themselves or by their poisonous properties destroy the minute plant life upon which the larvæ feed and thus starve the "wrigglers" and second those that form a film over the surface of the breeding place and kill the larvæ by strangulation. Tests of a number of each of these types have been made, several of which have proven more or less efficient.

Poisons.—Carbolic acid and Creosote are both fairly good larvicides as well as good general disinfectants but are too expensive for use except where a small quantity will suffice.

Phinotas oil manufactured by the Phinotas Chemical Co., of New York, was tried by the writer upon several small pools. It killed the larvae in all stages within a short time. Prof. Smith, however, states that it is not effective against the pupae at the same strength as against the larvae. No pupae were present in the pools treated so that it was impossible to verify this statement. The oil mixes readily with water disseminating quickly to all parts and giving it a slightly milky appearance. Its cost is slight being about 40 cents per gallon and a very small quantity is sufficient to treat a considerable amount of water. One drop in an ordinary glass of water containing a dozen larvae destroyed all the "wrigglers" in the space of a half hour. Two tablespoonfuls did the same for a half barrel of rain water, except that more time was required.

Chlornaphtholeum, another preparation by a New York Company is said by Prof. Smith to be an effective larvicide and disinfectant. It was not tested by the writer.

Lime and copper sulphate are both effective to some extent against the young larvae, but have no effect on the full grown ones or the pupae. They are both very slow to act allowing many of the "wrigglers" time to mature and escape. What value they have as insecticides is probably due to the fact that they destroy the small aquatic organisms that constitute the food of the mosquito and thus starve it to death. Lime in stagnant water, however, will discourage mosquito breeding and prove of value in that way.

Film Producers.—The oils depend for their larvicidal value upon their strangling effect upon the wrigglers. When applied to a pool a thin film is formed over the surface and as the larvae have to come to the surface to obtain air they come in contact with the oil film and their breathing pores are clogged by it.

Kerosene oil will form an even film over the water and kill all the larvae and pupae provided the whole surface is covered. An atomizer should be used in making the application so that the oil will be broken up into as fine particles as possible and thus will be distributed over a large surface. One ounce of kerosene will cover about 15 square feet of water surface. All vegetation should be removed from the pool before treatment as it will interfere with the formation of the film, and wherever the film is broken the wrigglers will congregate and develop undisturbed.

Crude petroleum is not as satisfactory as kerosene because partly composed of volatile oils, which evaporate, leaving only the heavy ones that draw together into large globules instead of maintaining the necessary even film.

As a general proposition the use of larvicides upon open pools is a satisfactory means of combatting the mosquito pest only in the exceptional instances where it is impossible to get rid of the breeding place. Here success is obtained only at the price of ceaseless vigilance. The chief objection to them lies in the fact that their effect is not permanent. In order to secure anything like permanent results is is necessary that applications be made at intervals or every ten days or two weeks at least, and in the event of a heavy rain following shortly after an application, breeding will again begin immediately in the treated water. This fault is common to both types as the poisoned water will be so diluted as to render the poison ineffective, and the films will be broken and either carried off by the surplus water or the surface so increased in scope that the oil will not cover it. It is difficult to maintain a film for any length of time even in the absence of rain, in the case of a pool of any size, as the wind will blow the oil either to one side or the other where it will be absorbed by the soil of the bank.

The poisonous applications have the additional undesirable feature that they destroy all species of predaceous insects and fish leaving the conditions almost ideal for mosquito development after the influence of the poison has been lost.

In the case of rain barrels, buckets, cesspools, etc., where the surface to be treated is limited and not subject to the influence of natural conditions to such an extent, the employment of larvicides is not so discouraging. Only a very small amount of material is required to treat such places and if proper precautions are taken the treatment will remain effective for sometime. On a rain barrel that is provided with a spigot at the bottom and not allowed to run over an oil film will remain for sometime even though the barrel is freshly filled after the application. A film over the water in a barrel so provided will not injure it for any ordinary use.

The solution of the mosquito problem may be summed up in these two recommendations. Get rid of all breeding places as far as possible, and treat the rest. The manner of handling each individual case of infestation must be largely governed by local conditions. With care on the part of property owners in looking after their own premises and cooperation by neighborhoods or municipalities in dealing with breeding grounds of extensive area the pest can be controlled if not eradicated and great benefits secured to the public.

Plate 1—Mosquito breeding pool in rear of flats near Corner of Montford Ave. and Ashland Ave. in Baltimore.

Plate 2—Dumping ground for old bottles, buckets, etc., in which mosquites breed near Eastern Ave. and 7th st., Highlandtown.

Plate 3—Accumulation of tin cans on vacant lot in Baltimore, in many of which mosquitoes were found breeding.

Plate 4—Collecting mosquitoes from standing water in railroad ditch.

Plate 5—Mosquito breeding swamp pool, created by damming of natural drains by railroad fill near Dunkirk on Sparrows Point Road.

Plate 6—Undrained stone quarry in northwestern Baltimore in which malarial mosquitoes were found breeding.

Plate 7—Quarry pool breeding mosquitoes on Coldspring Lane, Baltimore.

Plate 8—Wagon rut in woodland road, where mosquito larvæ were very numerous.

Plate 9—Street in Roland Park district, Baltimore, showing collecting larvæ from water in wagon ruts.

Plate 10—Salt marsh at Sparrows Point around edges of which mosquitoes were breeding in large numbers.

Plate 11—Swamp in Spring Garden district, Baltimore, breeding millions of mosquitoes which infest South Baltimore.

Plate 12—Swamp in neighborhood of Canton in which millions of mosquito larvæ were found.

Plate 13—Collecting mosquitoes from pool in pasture near Riverview.

Plate 14—Infested pool in Spring Gardens district.

Plate 15—Collecting from pool in pasture in Roland Park.

Plate 16—Spraying infested pools with Kerosene.

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